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VOLUME III

-W. R. Grace and Company-

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Mine and
Reclamation Plan

ENVIRONMENTAL IMPACT STATEMENT

NORTHWEST COLORADO COAL

U.S. DEPARTMENT OF THE INTERIOR
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W. R. GRACE COLOWYO MINE

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PREFACE

This is Volume III of the Northwest Colorado Coal Environmental Impact Statement. Contained herein is the environmental analysis of W. R. Grace and Company's proposed coal mine development. Although this analysis is intended to stand alone, some reference is made to the Regional Analysis found in Volume I. All impacts of W. R. Grace and Company's proposal are assessed over and above the future environment without the proposed action as presented in Chapter IV of the Regional Analysis.

Chapter I

Description of the Proposed Action

THIS CHAPTER IS A DETAILED DESCRIPTION OF W. R. GRACE & COMPANY'S PROPOSAL TO MINE AND RECLAIM FEDERAL COAL LANDS IN MOFFAT COUNTY, COLORADO. THE CHAPTER IS DEVELOPED BY DESCRIBING THE STAGES OF IMPLEMENTATION OF THE COMPANY'S PROPOSAL. THESE ACTIONS ARE USED IN CHAPTER III TO IDENTIFY AND ANALYZE IMPACTS. THE FEDERAL ACTIONS THAT WOULD BE REQUIRED ARE DESCRIBED ON AN AGENCY-BY-AGENCY BASIS AND OTHER DEVELOPMENTS IN THE AREA OF THE PROPOSED ACTION ARE DESCRIBED TO THE EXTENT THAT THEY MAY CONFLICT WITH OR COMPLEMENT THE PROPOSAL.

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

The Applicant's Proposal

In July, 1974, W. R. Grace and Company filed a comprehensive draft environmental impact assessment for a proposed surface-open pit coal mine, with the Office of the Area Mining Supervisor, U.S. Geological Survey (USGS). This report included baseline environmental data as well as a description of the mining plan contemplated for application on Grace's Federal coal lease. The action before the Federal government is approval of this mine plan. The USGS has determined that implementation of the Grace mine plan is a major Federal action significantly affecting the quality of the human environment. Pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, an Environmental Impact Statement is therefore required for approval of the plan. Refer to Chapter I of the Regional Analysis for a detailed description of the Federal procedures required for approval of the plan.

Since July of 1974 an additional drilling program has been conducted on the Grace property. Analysis of this newly acquired data enabled the company to formulate a new mine plan wherein the number of seams to be extracted by surface mining techniques has been expanded from four under the original plan to eight; estimated recoverable reserves subsequently increased over four times, from 35.5 million to 165 million tons.

The modified mining plan, reflecting the method devised for surface mining the upper eight seams, was filed with the Area Mining Supervisor on April 30, 1975; this followed the April 24, 1975, release of a Socioeconomic and Environmental Land Use Summary prepared for W. R. Grace and Company by

VTN. The mine plan covers the proposed mining operations for a 30-year period. The plan outlines the acreage in Federal lease D-034365 to be mined during this time period. Also included in the mine plan is an area, located in Section 11, T.3N., R.93W., that lies outside the present lease boundary. This area, designated as Tract A, contains federally-owned coal and lies contiguous to Federal lease D-034365, and can be mined as a logical extension of the Colowyo Mine. W. R. Grace and Company has submitted an application for a competitive lease for this tract. Because this area has been included in the mine plan and is encompassed by the time frame of this statement, this tract will be analyzed in conjunction with the mine plan on the company's Federal lease. However further analysis may be required at the time approval is granted for acquisition of this tract. It should also be emphasized that W. R. Grace and Company does not own this tract of land nor does it have any expressed right to acquire the tract. Tract A is shown in Figure GI-1.

The company has submitted maps and legal descriptions of three additional unleased Federal coal tracts, designated as B, C, and D, contiguous to coal lease D-034365. Grace has made application for competitive lease for these three tracts as well; if acquired they will be mined as an integral part of the proposed Colowyo surface mine but are not part of the current 30-year mine plan. Because the company's present plans for these tracts are not yet finalized and because the time frame of the plans for these tracts is outside the scope of this statement, no site specific analyses of them will be conducted in this report. These tracts are shown in Figure GI-1.

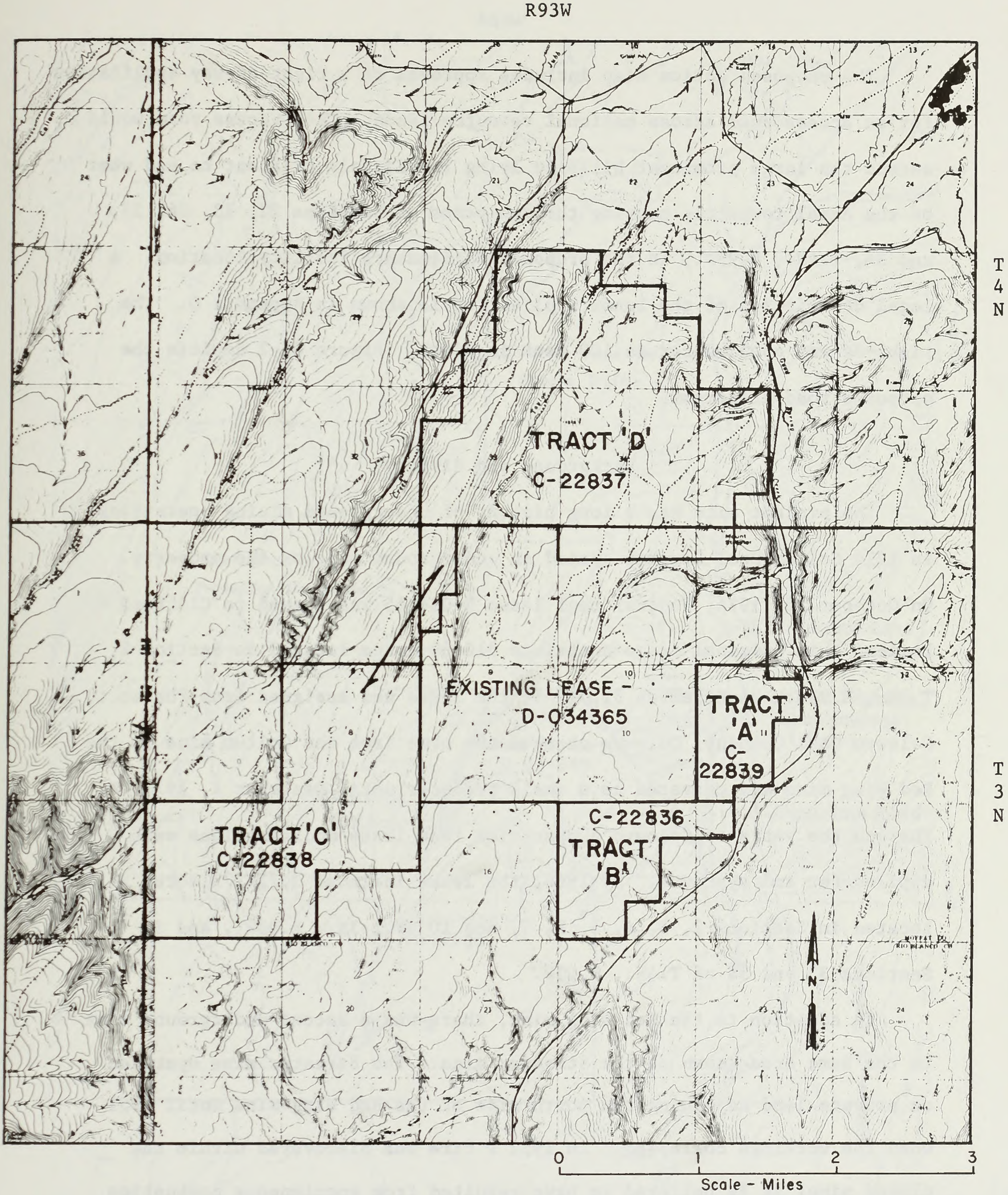


FIGURE GI-1

Competitive lease application tracts requested by W.R.Grace.

The proposed action also includes approval of a right-of-way application for an access road across national resource lands. This access road would ascend the large prominent hillside lying immediately adjacent to and west of the Axial townsite, passing through parts of Sections 22, 23, 26, 27, and 34, T.4N., R.93W., to the proposed maintenance facility location. A legal description of the lands applied for is shown in Appendix D. The right-of-way applied for is 100 feet in width. Figure GI-2 depicts the proposed road alinement.

Background and History

The project site has a long history of underground mining operations. In 1914 Collum Coal Company opened an underground mine on the property. On October 25, 1924, Federal coal lease D-034365 was issued to Clifford G. Phelan; this original lease contained 310.69 acres located in Section 2, T.3N., R.93W. On December 31, 1945, the lease was assigned from Phelan to Colowyo Coal Company; Colowyo changed the name from the Collum mine to the Red Wing mine and operated as a small producer until December 1, 1973. Through the years of Colowyo's operation four lease modifications were applied for and approved. By 1966, the lease included 3,724.73 acres located in Sections 2, 3, 4, 5, 8, 9, and 10 of T.3N., R.93W., and in Sections 33 and 34 of T.4N., R.93W.

In addition to the Red Wing mine, there was a second underground mine in the same area known as the Streeter mine. The Streeter mine operated on private land adjoining the north side of the Red Wing mine until 1951 when the workings collapsed. In 1952 a fire was discovered within the closed mine; it is believed to have resulted from spontaneous combustion of the coal seam, and is still burning.

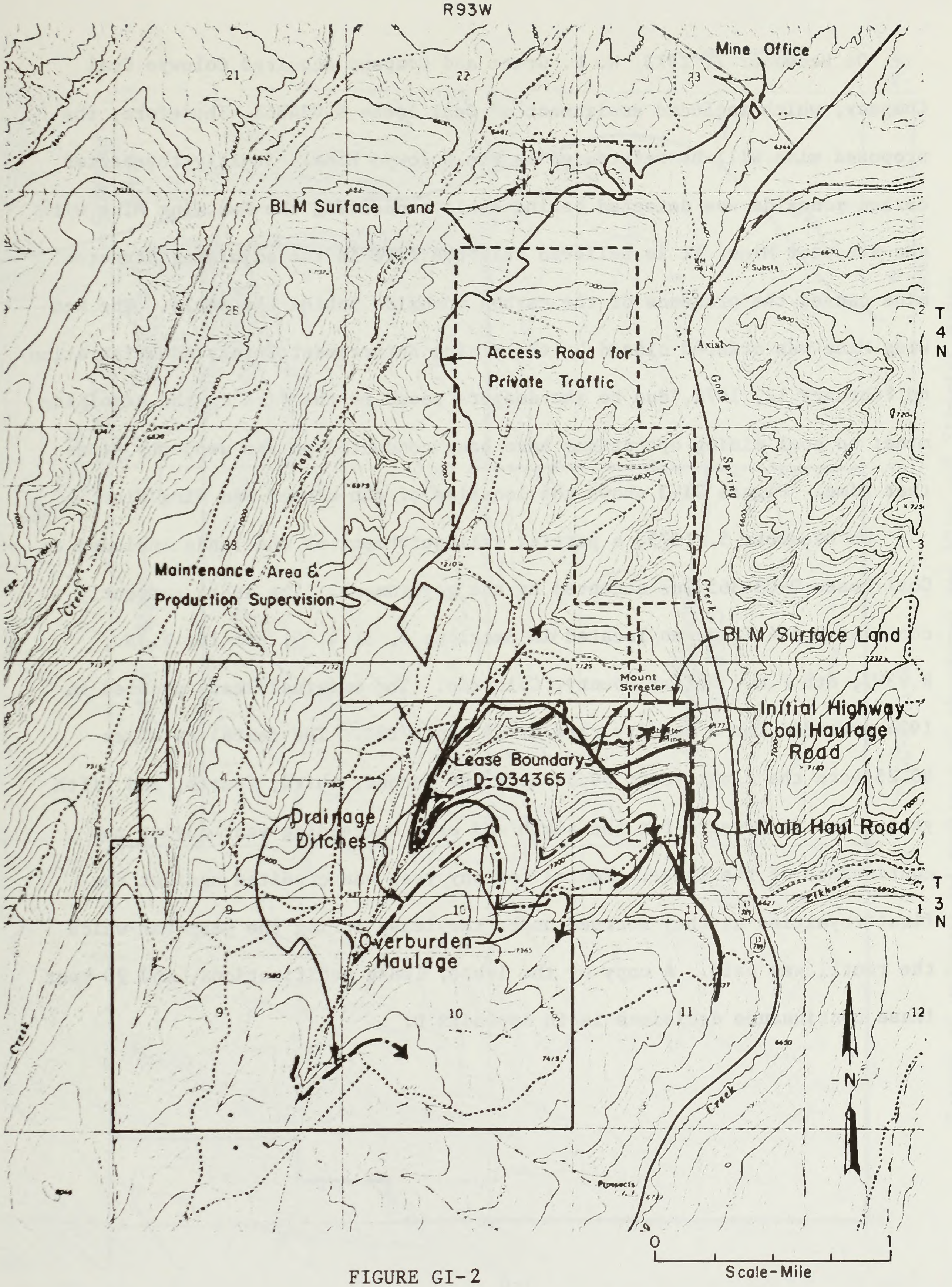


FIGURE GI-2

W.R.Grace-Colowyo Mine, map of surface facilities.

On December 1, 1973, W. R. Grace and Company acquired Colowyo Coal Company, which included assignment of Coal lease D-034365. Therefore, the proposed mine will be referenced as the Colowyo Mine. Shortly thereafter carbon monoxide was detected behind seals connecting the Red Wing Mine with the Streeter Mine. It is believed that the fire in the adjoining Streeter mine caused the presence of the carbon monoxide behind the seals. The Red Wing Mine was ordered closed by the Mining Enforcement Safety Administration on February 12, 1974, due to the dangers posed by the fire in the adjoining mine; no coal mining operations have been conducted on the property since that time. Figure GI-3 shows the location of the closed Red Wing Mine.

On December 5, 1975, a partial relinquishment of the lands included in Coal Lease D-034365 was accepted by the government. The lease currently contains 2,564.79 acres located in Sections 2, 3, 4, 9, and 10, T.3N., R.93W., 6th P.M., Moffat County, Colorado. The original lease granted in 1924 provided for a royalty rate of 15 cents/ton. The rental rate was $0.25/acre the first year; $0.50/acre the second, third, fourth, and fifth years; and $1.00/acre for the sixth and each succeeding year during the continuance of the lease. Rental for any year was credited against the first royalties as they accrued under the lease during the year for which the rental was paid. A copy of the lease, lease modifications, and 20-year lease continuance decisions is in Appendix D.

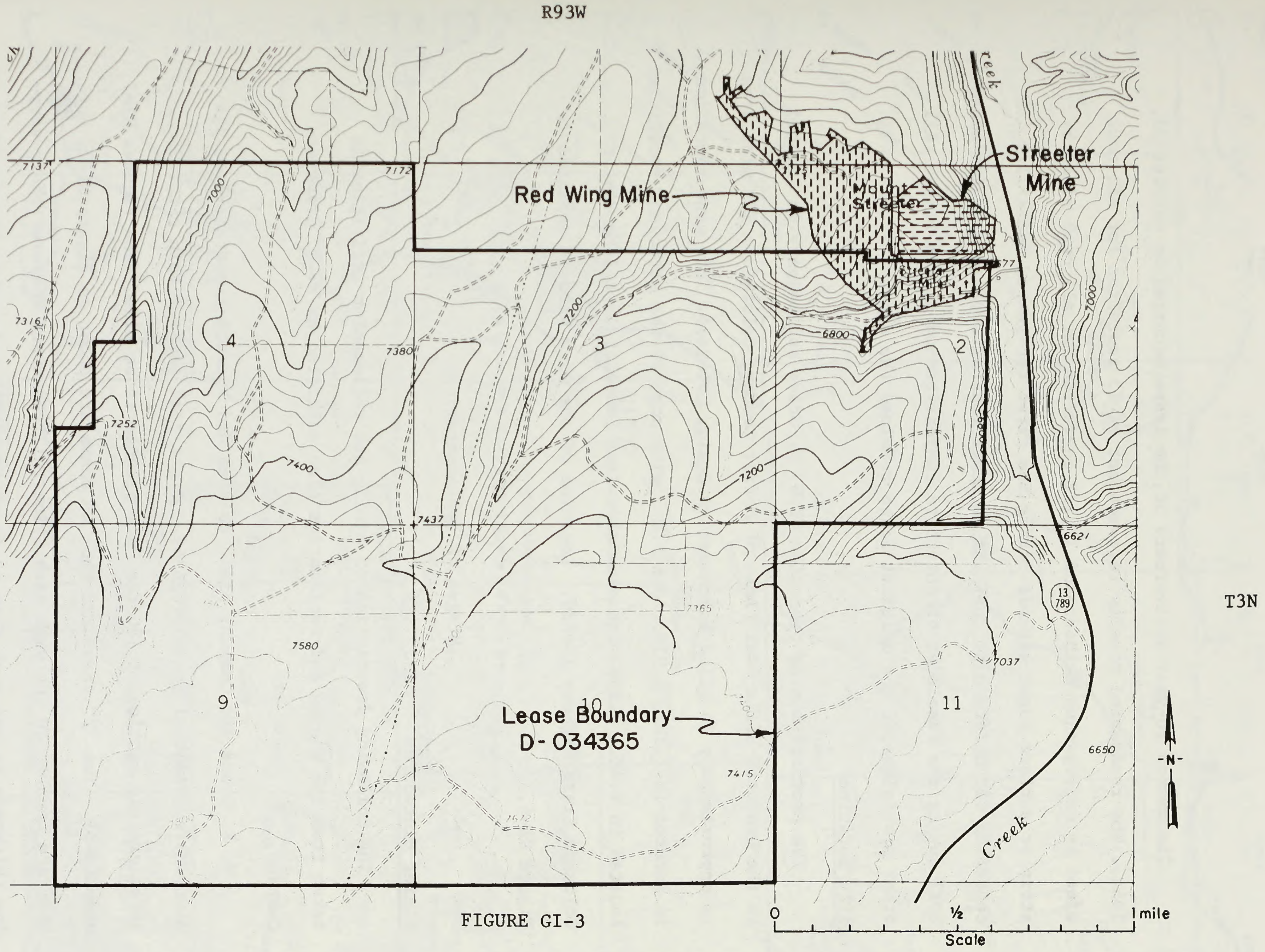


FIGURE GI-3

Extent of underground workings of abandoned Red Wing and Streeter mines.

The second 20-year anniversary of the lease occurred on October 25, 1964. The readjusted royalty rate was set at 15 cents/ton for all coal mined by underground methods and 17 1/2 cents/ton for all coal mined by strip or surface auger methods during the first ten years, and 17 1/2 cents/ton for underground coal and 20 cents/ton for surface or auger mined coal during the remainder of the third 20-year period of the lease. All other provisions of the original lease remained the same.

Site location

The proposed mining operation of W. R. Grace and Company is located in the Danforth Hills Coal Field of Moffat County, Colorado. The mine area is approximately 25 miles southwest of Craig, Colorado. The mine operation is located in T.3N., R.93W., 6th P.M., with some of the attendant facilities located in T.4N., R.93W. The mine area lies immediately to the west of Colorado State Highway 13-789. Location of the mine site is depicted in Figure GI-4.

Stages of Implementation

Mining procedures

The following description of mining and reclamation activities is taken from the mining and reclamation plan submitted by W. R. Grace and Company.

W. R. Grace and Company plans to open and operate a surface-open pit mine on Federal coal lease D-034365. Eight coal seams within a total stratigraphic section of 390 feet are planned to be mined (see Figures GI-7 and GII-3). Two "Y" seams and two "A" seams are shown on Figure GI-7, but they are counted as one seam each. They will be mined whenever their varying thickness is not such that it is economically unfeasible to mine them.

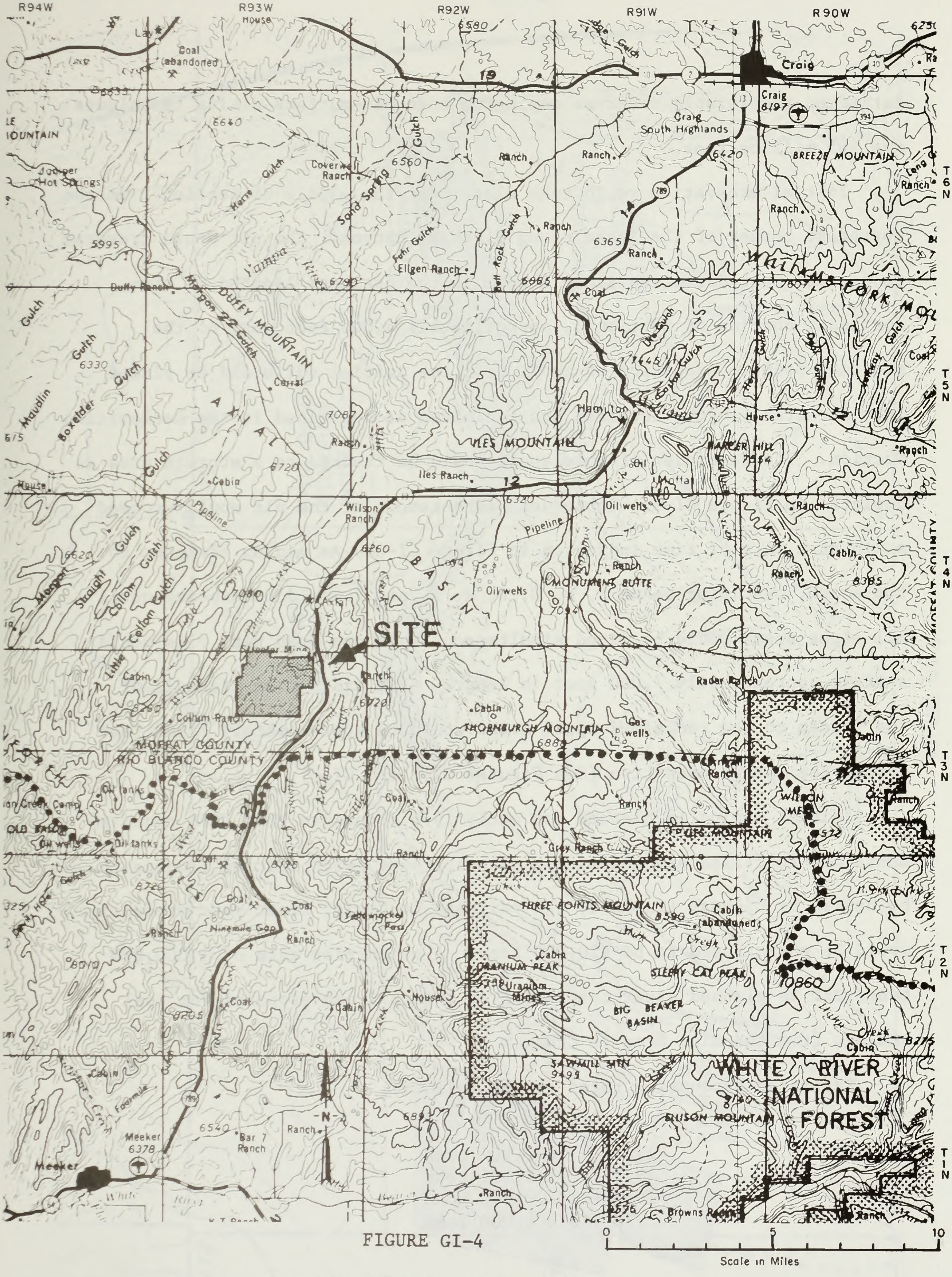


FIGURE GI-4

Location of Colowyo mine site.

Estimated recoverable reserves employing open-pit surface mining techniques are 165 million tons.

Initial excavation would take place near the middle of Section 2 in the northeast corner of the lease along Streeter Canyon. The pit would traverse in an east-west direction along F seam to the drainage located in the northeast portion of Section 3, approximately 4,000 feet west of the starting point. A portion of spoil from the initial cut would be placed into Streeter Canyon, leveled, and reclaimed as described in the Reclamation Section. The remainder of this spoil would be trucked to a storage area as depicted in Figure GI-5. Subsequent advancement of the pit would proceed south at a rate of time indicated in Figure GI-6. As mining advances to the south, overlying seams E, D, C, B, A, X, and Y would be exposed until all eight seams would be mined simultaneously in one open pit; pits would average approximately 7,000 feet in length. Pit width from highwall of the Y seam to the reclaimed spoil areas would be approximately 1,900 feet during the mature operation (See Figures GI-7 and GI-8).

Initial mining is planned for early 1976 (provided that NEPA requirements are fulfilled and the mining plan approved) with initial tonnage to be hauled by highway trucks to the railhead in Craig; first year production would be anticipated to be 620,000 tons. A production rate of 3,000,000 tons/year is planned after completion of the railroad proposed for coal haulage from the mine area to Craig.

Estimated production rates are as follows:

1976 - 620,000 tons
1977 - 900,000 tons
1978 - 1,200,000 tons
1978 - 3,000,000 tons

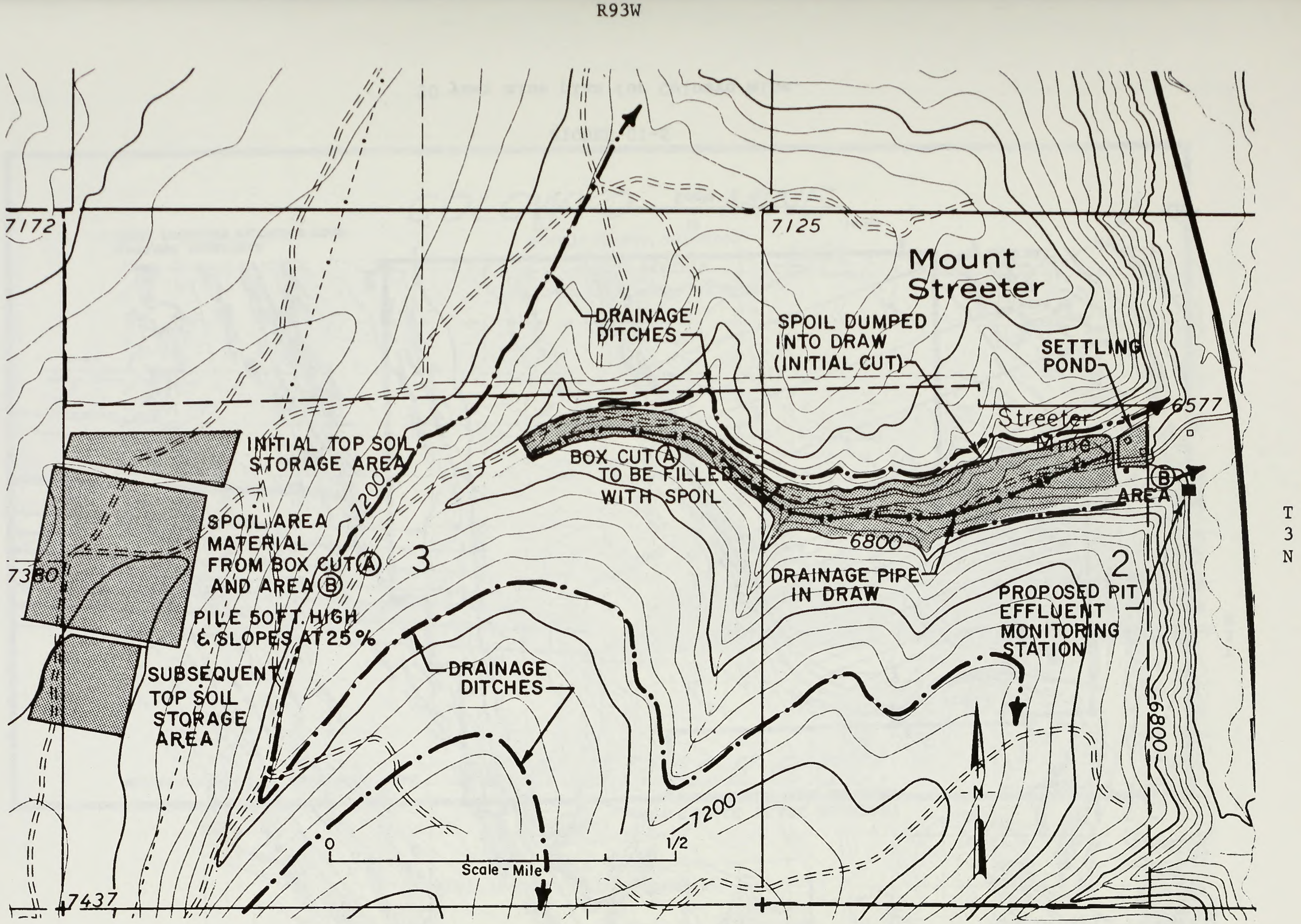

R93W
T 3 N
7172
7125
Mount Streeter
DRAINAGE DITCHES
SPOIL DUMPED INTO DRAW (INITIAL CUT)
SETTLING POND
6577
Streeter Mine
INITIAL TOP SOIL STORAGE AREA
BOX CUT Ⓐ TO BE FILLED WITH SPOIL
Ⓑ AREA
7200
SPOIL AREA MATERIAL FROM BOX CUT Ⓐ AND AREA Ⓑ
3
6800
2
7380
DRAINAGE PIPE IN DRAW
PROPOSED PIT EFFLUENT MONITORING STATION
PILE 50 FT. HIGH & SLOPES AT 25%
SUBSEQUENT TOP SOIL STORAGE AREA
DRAINAGE DITCHES
6800
N
7200
0
1/2
Scale - Mile
7437

FIGURE GI-5

Spoil and topsoil stockpile area.

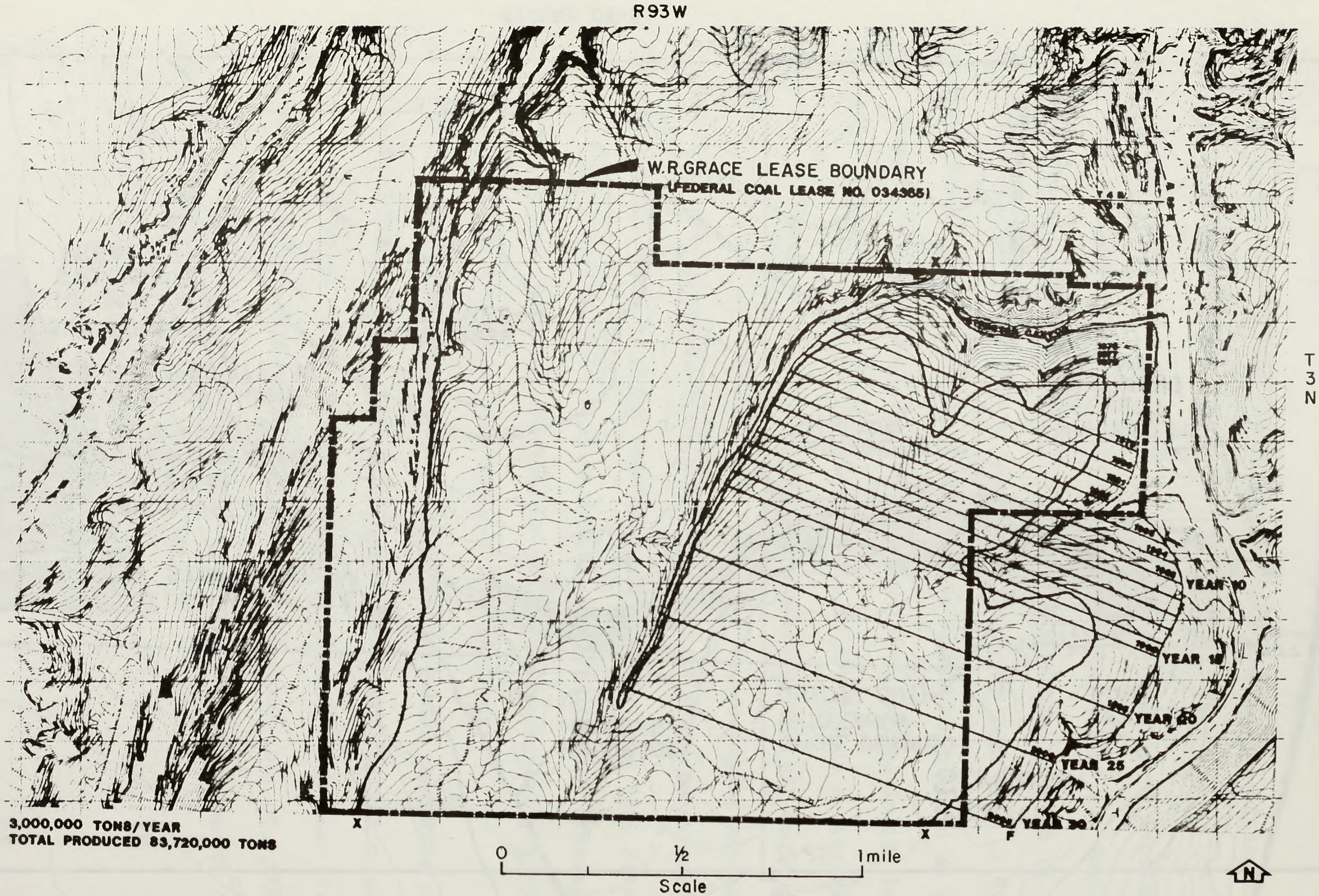


FIGURE GI-6

30 year mine plan for Colowyo mine.

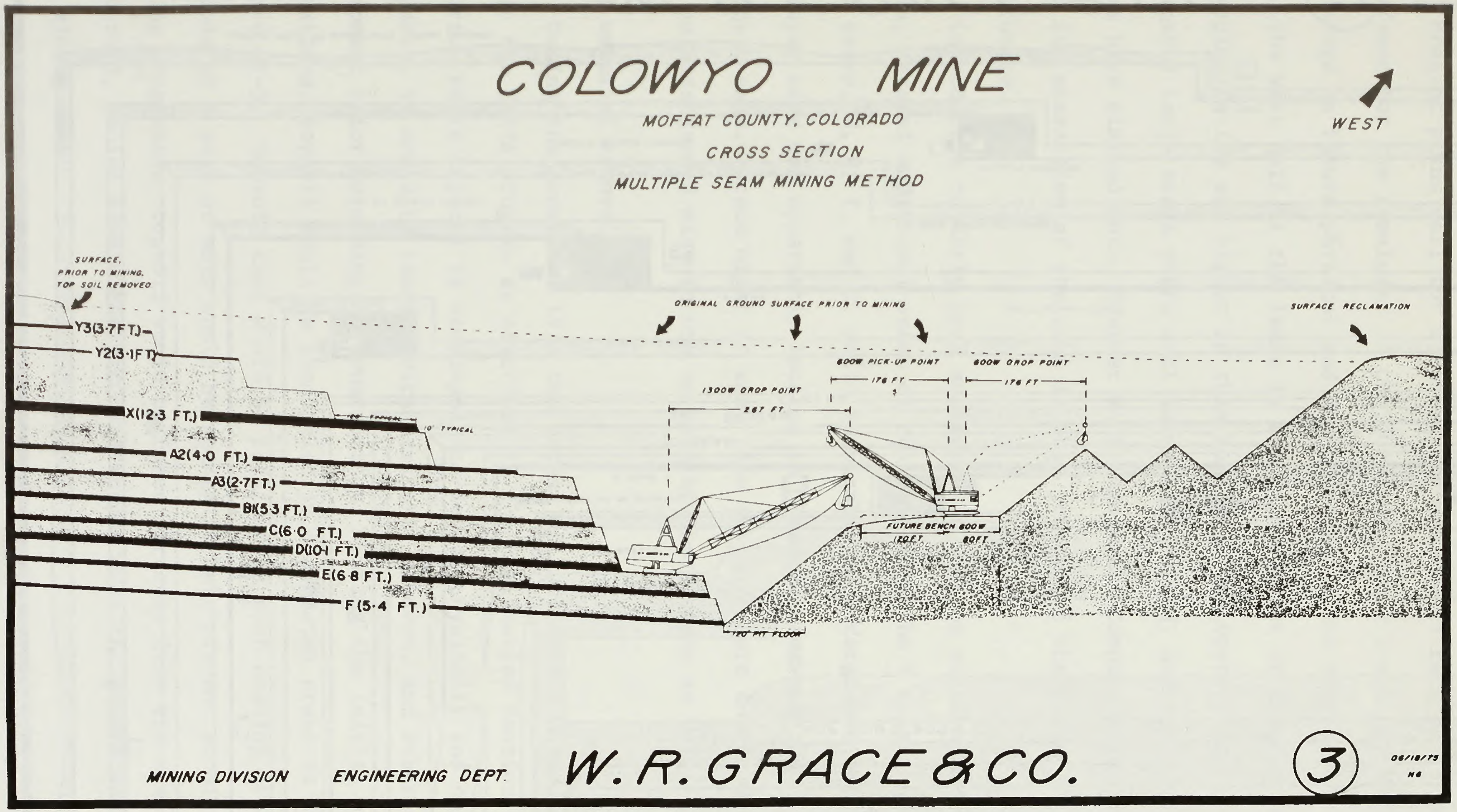


FIGURE GI-7

Multiple seam mining method.

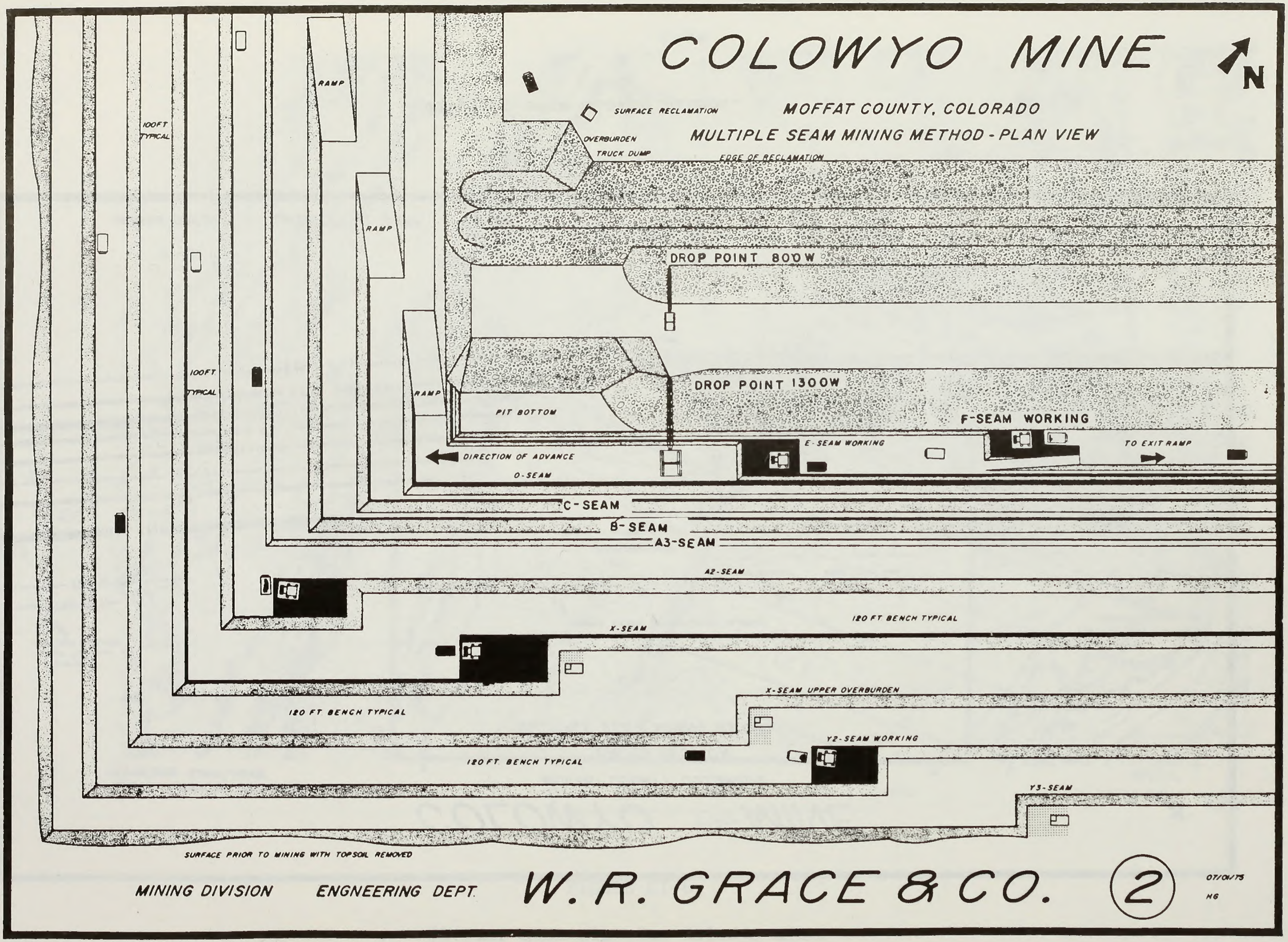


FIGURE GI-8

Multiple seam mining method.

Present plans call for a continuing production rate of three million tons/year for the remainder of the 30-year life of the mine; this is subject to change as future physical and economic conditions warrant.

The west half of the lease is the second phase of the mine operation. Stripping ratios are higher in this half, and exploratory drilling has indicated large areas where coal seams have burned, and other areas where seams have pinched out. However W. R. Grace and Company might file a mine plan for extraction of the coal in this portion of the lease some time in the future.

In addition to strip coal available in the top eight seams of the lease, several additional seams of coal underlie the F seam. At least four seams, G, H, I, and J, would be minable by underground methods. Streeter mine was apparently located in G and H seams and the Red Wing mine in the G seam. Grace might at some time in the future submit mining plans for an underground mine in one or more of these seams as well.

Soil material removal

During the summer of 1974 the Bureau of Reclamation mapped soil types under the EMRIA program as described in the Reclamation Section of this report. Where topsoil is developed and deemed physically and chemically suitable, it would be removed with scrapers, graders, and other appropriate equipment prior to mining or construction. During the initial mining operations, topsoil would be stockpiled in designated areas as shown in Figure GI-5. Topsoil that would be retained in such holding areas for periods of a year or more would be seeded to help prevent erosion. As mining progresses, topsoil would be taken directly from the area to be disturbed, hauled around the pit, and spread over the graded spoil behind the mining area.

Overburden removal

Overburden removal would be accomplished in the following manner: during the initial phase of mining, after removal of the topsoil, overburden overlying the F seam would be prepared. Blast holes would be drilled with rotary drill units to the top of the F seam. Hole spacings and diameters would vary according to overburden thickness and characteristics. The holes would be loaded with ANFO and detonated sequentially with electric caps, primacord, and primers.

Shot material would be leveled and a bench prepared for the dragline by caterpillar bulldozers. The overburden would then be stripped with a 28-cubic-yard dragline equipped with a 195-foot boom. The dragline would work from a bench located west and upslope of the shot; broken overburden would be dug and cast to an area north of the shot. Initial overburden would be placed into Streeter Canyon, as the F seam outcrops within 200 feet of the canyon floor; this initial cut would be 120-150 feet in width. A portion of this spoil would be rehandled and trucked to an area west of the pit as depicted in Figure GI-5.

Mining would progress west along the outcrop of F seam to the canyon located approximately 4,000 feet west of the starting point. The dragline would then be walked back to the area immediately south of the first cut, and the next cut would be started. As F bench progresses, the next four seams encountered (E, D, C, and B,) would be treated in the same manner in sequence. Topsoil would be removed and transferred to a storage site, overburden drilled, shot, stripped, and cast by the dragline to an area north of the pit or into the mined-out pits. During the first two years of operation five seams would be exposed and mined in the pit.

The second stage of operations would begin in mid-1977 with the delivery of another dragline. This dragline would be equipped with a 40-cubic-yard bucket and a 285 foot boom. Upon delivery and construction, it would be walked to the highwall to replace the smaller dragline. Overburden material overlying five seams, A through E, would then be stripped with the 40-yard dragline. The 28-yard dragline would be relocated in the spoil area on the north side of the pit and would rehandle excess overburden material. The 40-yard dragline does not have a sufficient dumping radius to prevent overburden from the lower seams from covering the exposed coal. The 28-yard dragline would therefore be used to pick up this excess material and redeposit it further north of the mining operation. Plan and end views of this procedure are shown in Figures GI-8 and GI-9.

When X and Y seams are uncovered (early in 1979) and all eight coal seams exposed, the mature pit would be in the configuration shown in Figures GI-8 and GI-9. Sometime thereafter the overburden would be of quantity and depth that would preclude continuing in the above described manner. At this stage, a 22-cubic-yard power shovel, heretofore used for coal loading, would be re-equipped with a 15-cubic-yard dipper, and would be used for loading the overburden above the Y, X, and F seams. In this truck and shovel operation, 170-ton off-highway rock trucks would haul overburden material to the spoil area at the north side of the pit for final backfill. Great flexibility would be gained using the truck and shovel method of mining on the X and Y seams, as overburden removal could be accomplished either east or west, and the resultant material could be trucked to the spoil area and dumped precisely where it would be required for completion

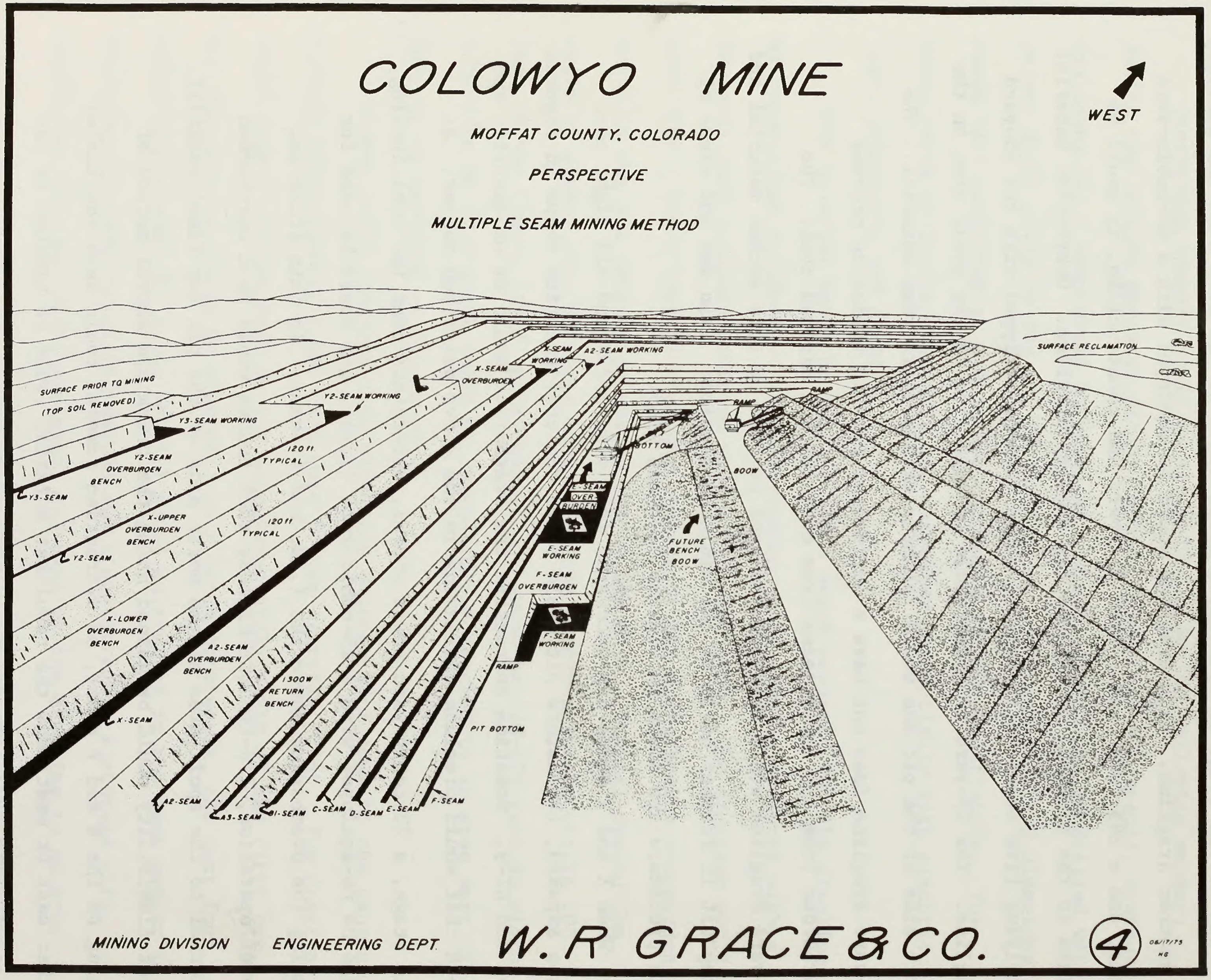


FIGURE GI-9

Multiple seam mining method.

of the backfill process. This integration of dragline stripping and truck-and-shovel operation would be ideally suited for extraction of the eight coal seams both from a reclamation standpoint and an economic one.

Coal removal

Coal removal methods would vary somewhat, as would overburden removal methods and procedures, as the mine advances from stage one through stage two. During the first stage of operation, coal would be loaded, following drilling and shooting, with the 22 cubic yard power shovel or with front-end loaders into highway type trucks. The trucks would haul the coal via State Highway 13 to the temporary load-out facilities near Craig.

As the pit reaches maturity, in the latter part of 1977 or early 1978, it is anticipated that construction of the rail-line from Craig to an area north of the mine would be completed. When the rail line, crushing units, and loading facilities would be operational, the company's 170-ton off-highway trucks would be employed for transportation of the coal from the mine to the loadout site. By late 1978 or early 1979, the power shovel would be engaged in loading rock overburden in the truck and shovel operation, and all coal loading would be accomplished with front-end loaders. During the second phase of operation, coal loading could take place from two or more seams simultaneously, as the dragline operation in the lower seams and the truck and shovel operation of the upper two seams, could proceed independently of one another.

Reclamation

It is the intention of W. R. Grace and Company that their surface mined lands be returned to a condition at least as good as that which now exists, and that they be suitable for wildlife habitat and domestic livestock grazing. At this time Grace is still discussing alternatives to a number of reclamation approaches to achieve their land use goal. As more information is gathered from the various ongoing environmental and engineering studies, or as new technologies develop, the reclamation plan will be modified.

W. R. Grace has initiated a four-year revegetation study, July, 1975, to determine the suitability and practicality of utilizing shrub species native to the Colowyo mine site. This program will simulate the disturbance that would result from surface mining. All existing vegetation will be removed from the plots, and the top one inch of soil will be removed to reduce weed infestation. Then all topsoil remaining will be removed and subsequently redistributed over test plots. A variety of experiments will be conducted to determine which plants and what methods are most suited for revegetation. One is designed to test the adaptability of established shrubs to be transplanted while another will determine the potential for natural reintroduction of nitrogen into the topsoil material.

Since the design and purpose of the revegetation study is to reestablish native browse vegetation, wildlife studies are in progress to supplement the revegetation tests. The amount of big game utilization per plant species is currently being measured on the Colowyo Mine site. This information will be used to determine the percentage of each species that should be planted to provide suitable wildlife habitat. Small mammal studies are also in progress to determine the potential problems that may exist from rodent grazing. Habitat improvement projects are already underway to improve big game habitat, prior to mining, in an effort to provide use areas for displaced animals when mining operations would begin.

Reclamation of the mine would begin immediately with start-up of operations. Vegetation would be removed and shredded, although its usefulness has not yet been determined. A number of approaches are under consideration: the shredded vegetation might be mixed with the topsoil and left to decay; it might be windrowed and burned and the ashes later mixed with the stored topsoil; or the material might be composted for use as a mulch when revegetation begins. Each of these approaches has a number of inherent problems. Direct mixing of plant materials with the topsoil might tie up nutrients in the decomposition process which are essential to soil development and plant establishment; seeds of undesirable species might also be introduced into the topsoil material. Burning might volatilize many nutrients, while composting might take too long or prove uneconomical to satisfy reclamation goals. It is the intention of W. R. Grace and Company to investigate each of these alternatives and perhaps carry out additional tests on revegetation test plots.

After vegetation removal, topsoil would be removed by scrapers or other suitable equipment and stored in long mounded terraces outside the mine area. This would be a continuing process prior to overburden removal. Storage piles would be contoured and seeded with legumes and wheatgrasses to abate erosion and blend with existing surrounding topography. As the mining sequence allows, some topsoil on removal might be placed directly onto surfaces readied by backfilling and grading. The surface would be ripped prior to topsoil replacement to relieve compaction.

During the first period of mining, spoil piles would be leveled by bulldozers as desired elevations are reached. In the mature pit, trucks would transport broken overburden material into the north edge of the pit and dump it into the voids between the piles. Final grading of the spoils would also be accomplished by bulldozers.

Broken rock material from initial cuts would be cast into piles on the bottom of Streeter Canyon. As the first piles accumulate in height they would be graded from time to time to attain a configuration less than the angle of repose, but not more than 25 percent grade (Figure GI-10). Terraces would be made along the pile slopes to impede surface water runoff, and contour furrows placed at the toes to capture any sediment. As first mining proceeds westerly up the canyon, the F seam does not outcrop at the western end (according to drilling data.) At that time it might be necessary to make a box cut. Spoil from the box cut would be trucked to the approximate area of the topsoil storage piles, contoured, terraced, and seeded to achieve stabilization until such time as spoil could be utilized for backfill. Diversion ditches would be constructed along the north slope of Streeter Canyon to carry surface water around the operating area and discharge it into the natural drainages outside the area. An appropriate conduit would be placed along the bottom of Streeter Canyon, on grade to the west end of the box cut, prior to initial casting of spoils to concentrate any surface water higher up the canyon and allow preservation of the present drainage elevation. Spoil would be placed over the conduit from the initial cuts and the conduit left in place permanently (see Figures GI-5 and GI-10).

Backfilling, grading, topsoil replacement, and seeding would begin twelve-eighteen months after opening of the initial cut, depending upon weather conditions. In the mature operation, reclamation work would be

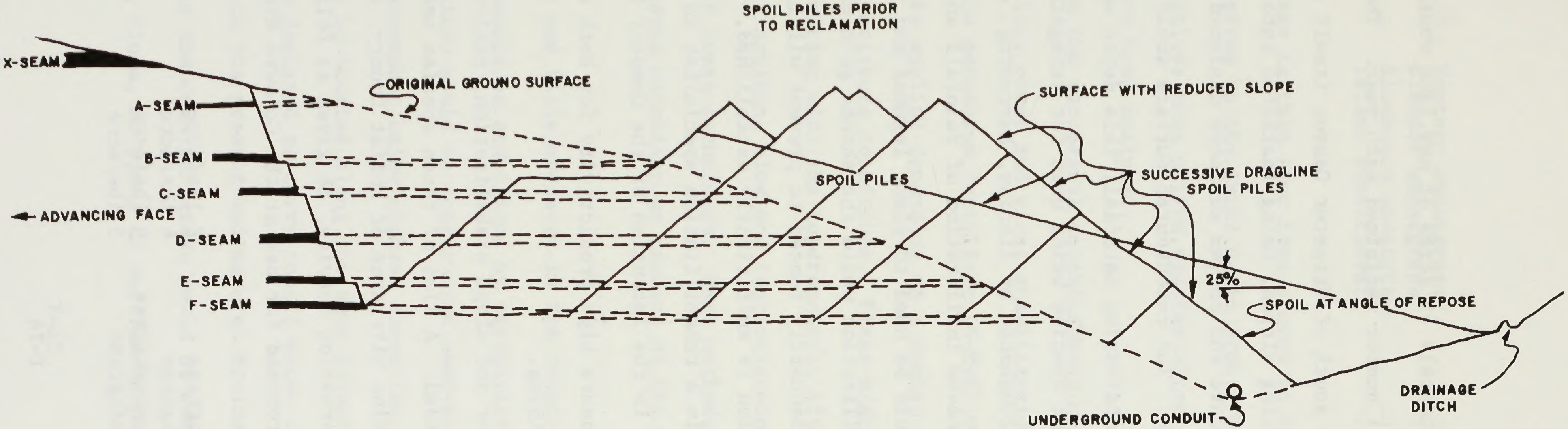


FIGURE GI-10

Schematic diagram of overburden to be dumped into Streeter Canyon after grading of the original spoils, looking west.

concurrent with mining; approximately 45 acres of new land would be disturbed annually and an equal number reclaimed each year. The topography of the reclaimed surface south of Streeter Canyon itself would reasonably conform to the existing slopes, being feathered into the contiguous natural surface, with concave and convex surfaces designed to recreate a variety of micro-environments. The recontoured surface would be covered with up to 18" of the stored topdressing material; this depth would depend on the requirements of the plant species being used for revegetation. The covered surface would then be roughened by discing, harrowing, chiseling, or combinations thereof to increase infiltration of rainfall and prevent erosion. A rangeland drill would be used to plant legumes and grasses to provide initial cover and stabilization while the shrubs gain establishment. All reclaimed areas would be adequately fenced to prevent wildlife or domestic grazing until vegetation is sufficiently established. W. R. Grace and Company also plans to retain a rehabilitation specialist to insure success of the reclamation; it is the intention of the company to implement judicious land management to insure high productivity for both domestic livestock and wildlife after mining.

To insure early plant cover and slope stabilization, native and introduced grasses would be seeded. A list of these species and recommended mixture adapted to the mine site area of Moffat County, utilizing information from the Soil Conservation Service, is given as follows (no specific seed mixture is yet proposed for use at the Colowyo Mine area):

Kentucky bluegrass	2 lbs/acre
Manchar bromegrass	4 lbs/acre
Intermediate wheatgrass	4 lbs/acre
Pubescent wheatgrass	3 lbs/acre

Western wheatgrass	3 lbs/acre
Slender wheatgrass	3 lbs/acre
Bluebunch wheatgrass	3 lbs/acre
Yellow sweetclover	2 lbs/acre

The species in this list have proven to be successful for revegetation of disturbed sites in the Axial Basin area. However, this list will be expanded to include more native species after the results of the revegetation study have been analyzed.

To insure the successful establishment of the grass species recommended for initial plant cover and plant stabilization, a balanced nitrogen, phosphorus, and potassium fertilizer (N-P-K) would be used. Rates of 50-75 lb/acre will be applied depending on a number of variables, one of which is soil moisture conditions. Plans might include applications prior to planting (mixing with the topdressing), after seedling emergence or transplanting, applying slow and fast releasing forms (urea-nitrogen), or a combination of these techniques. Best methods of fertilizer application would be employed depending on results of the revegetation test studies now underway.

All cuts and fills produced in the construction of haul roads and access roads would be stabilized by revegetation.

A main ditch would be constructed east-west across the east half of the property somewhat below highest elevation. Two or three intermediate ditches would be located along the same directions at lower elevations; they would be designed to carry runoff water from precipitation downslope and eastward to its present and natural drainage area. Water accumulations, encountered in the open pit areas would be pumped out and carried by conduit, either ditch, flume, or pipe, to settlement ponds. W. R. Grace and Company has been participating in water studies in the area with Federal government agencies to determine quantities and qualities of water produced at the mine site. Specifications of the settling ponds would be based on the results of those studies for effective use. Discharge water from settlement ponds would be monitored for chemical and sediment standards at a point prior to release into the natural stream or drainage, and treated if necessary.

Compliance with applicable air and water quality standards would be maintained throughout the duration of the operation. Fugitive dust would be controlled with water spray distributed by water trucks. All machinery, equipment, and materials to be employed in the operation would be equipped with safety devices and designed to comply with the requirements of the Mine Enforcement Safety Administration and other regulatory agencies.

Surface facilities

Most of Grace's proposed surface facilities are located on private land owned or controlled by the company. The company's proposed surface facilities are as follows:

Roads

The company's proposed haul roads are located for the most part on privately-owned surface land. Portions of roads crossing federally-owned land have previously been identified in Figure GI-2. Main haul roads would exit from both ends of the pit and proceed north. During the initial stage of operations, the haul roads from each side of the pit would funnel into Streeter Canyon and then to State Highway 13 over which the coal would be trucked to the railhead at Craig. Following completion of the planned spur track and loading facilities just north of the mine area, the haul roads from each side of the pit would join in Section 3 and would proceed north through Section 34 to the dumping facility. The main access road would proceed from the mine office site in Section 23, T.4N., R.93W., through Sections 27 and 34 to the maintenance facilities. A cross-section of the main haul road on the east end of the pit is depicted in Figure GI-11.

Railroad spur

The proposed railroad spur and related loadout facilities are discussed in the site specific analysis of the railroad.

Power

Electrical power for the draglines, shovel, shop, crushing station, and loading facilities would be required. Power for mining equipment would be supplied by a 69-kv transmission line extending from an existing transmission line that passes along the east side of the lease, paralleling State Highway 13 in Sections 2 and 11. The line serving the mine area would pass through a substation to be located in the southeastern part of Section 2. Distribution to the mine area would be by overhead line to portable substations and thence by trailing cables to in-pit equipment. This line, depicted in Figure GI-12, would be located on privately owned surface acreage that is held by Grace. Power for the loading facilities and crushing station would be supplied by a line running across private land in Sections 3 and 34 from the mine distribution line.

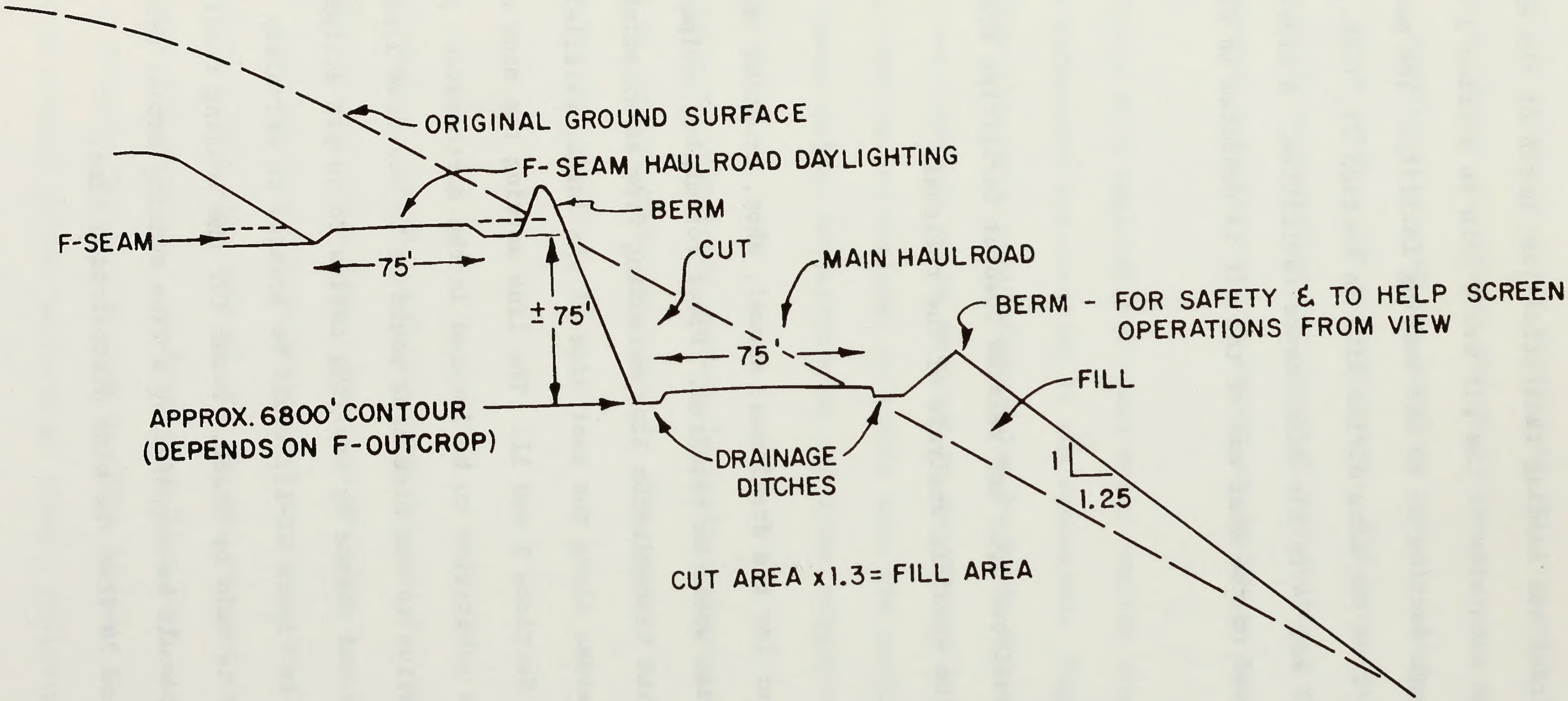

ORIGINAL GROUND SURFACE
F- SEAM HAULROAD DAYLIGHTING
BERM
F-SEAM
75'
± 75'
CUT
MAIN HAULROAD
BERM - FOR SAFETY & TO HELP SCREEN OPERATIONS FROM VIEW
75'
FILL
APPROX. 6800' CONTOUR (DEPENDS ON F-OUTCROP)
DRAINAGE DITCHES
1
1.25
CUT AREA x 1.3 = FILL AREA

FIGURE GI-11

Proposed haul road showing average disturbance along the east side of the Colowyo Mine.

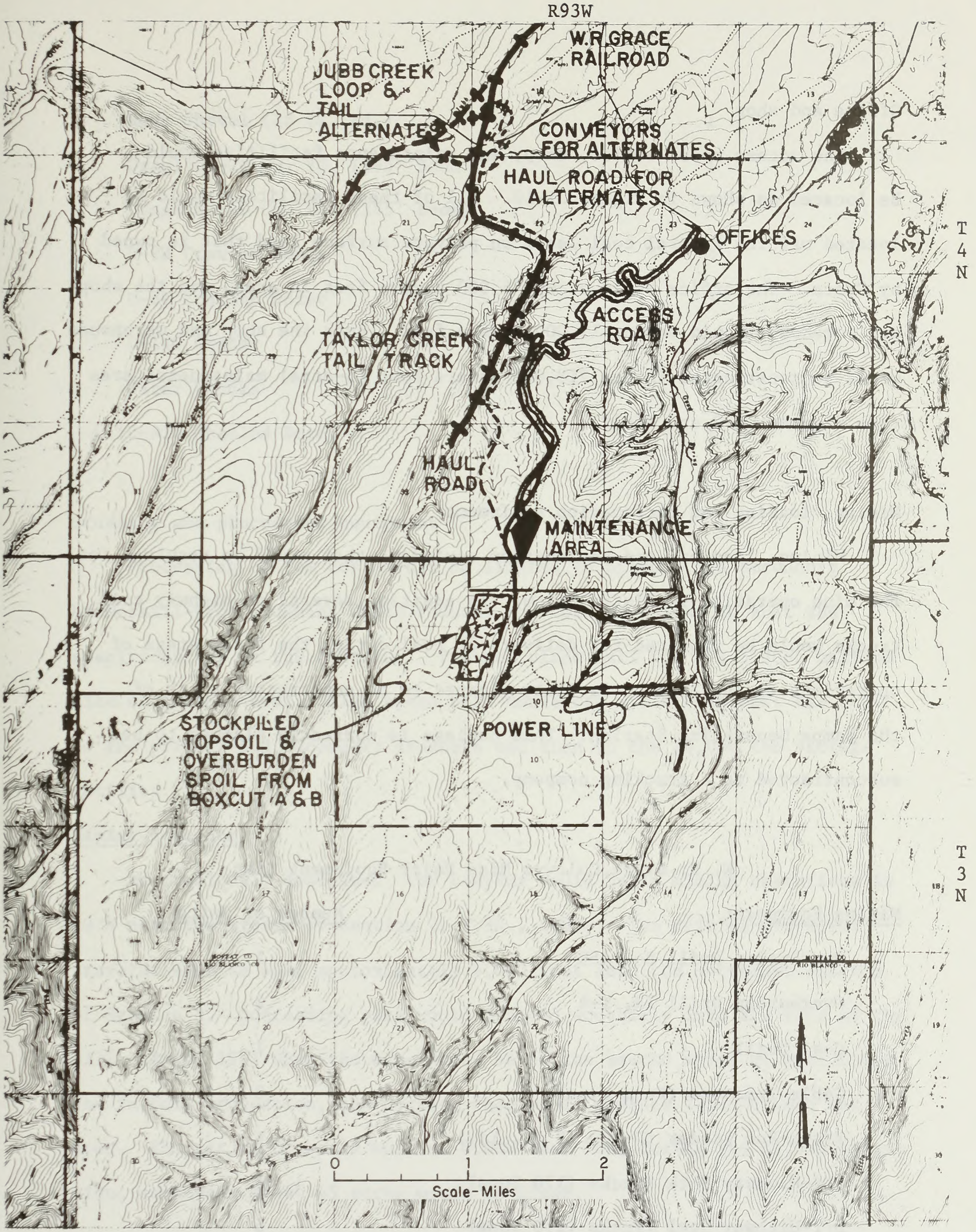


FIGURE GI-12

Proposed surface facilities and developments.

Office and shop

The access road, office, shop, and maintenance facilities would be located as shown in Figure GI-12. All of these facilities would be located off the Federal coal lease on private surface land that is owned by Grace. The office would occupy 6,000 square feet in area, and the shop and warehouse would occupy 11,000 square feet. Both the shop and warehouse would be constructed in the 218,000 square foot (5-acre) maintenance area (see Figures GI-2 and GI-12).

Mining, loading and reclamation equipment

Mining, loading, and reclamation equipment that would be required for the mine operation is listed below. In addition several on-highway coal trucks would be required for delivery of coal during the first stage of operations to the loading facility planned to be constructed south of the Yampa Generating Station. This haulage is currently planned to be subcontracted to a trucking company.

W. R. Grace Colowyo Mine Major Equipment List

Mining Equipment	Number of Units
Overburden Drill B-E 45R	1
Overburden Drill IR, T-4	2
Coal Drill	1
Cable Tractors (Farm Type)	2
Front-End Loader (D-600 15 Cu. Yd.)	4
Off-Highway Rock Trucks (170 Tons)	7
Off-Highway Coal Trucks (170 Tons)	6

Rock Shovel (15 Cu. Yd.)	1
Dragline-28 Cu. Yd. (195' Boom)	1
Dragline-40 Cu. Yd. (285' Boom)	1
D-9H Crawler Dozer	3
D-8K Crawler Dozer	3
D-14G Grader	1
Water Trucks	1
D-824 Wheeled Dozer	1

Crushing and processing equipment

Processing of the coal would be limited to primary and secondary hammermill-type crushing which reduces the coal to a size to suit the specifications of the customer. Present plans call for a 1.5 inch maximum size of crushed coal. High speed belt conveyors would transport the coal to the primary and secondary crushers and then to the 24,000 ton storage facility.

Mining sequence

As previously described, the company would begin mining operations in 1976 near the middle of Section 2, T.3N., R.93W. The initial pit would traverse east to west approximately 4,000 feet into the northeast portion of Section 3. Succeeding pits would proceed southerly into the side of the hill. After 1977 when the mine would be in the second stage of operations and in full production, the working face would advance 250-350 feet per year. The pit might be as much as 8,000 feet long during the mature operation; each year about 45 acres would be mined.

The mine plan covers a 30-year operation, at which time the pit would have progressed to the southern portions of Sections 10 and 11. Production is expected to be 3,000,000 tons/year. The western half of the Federal coal lease has been designated as Phase II and would be mined at a later date.

Transportation and marketing

The mine would supply various undetermined consumers in the eastern and southeastern United States. During the first stage of operations, coal would be trucked via State Highway 13 to a loading facility presently planned to be constructed south of the Yampa Project generating station, 25 miles away. Following completion of a new spur line and loading facilities just north of the mine area, this on-highway truck haulage would cease and the new spur track would be used for rail shipment of the coal.

Relationship to Other Developments in Immediate Area

There is presently one other operator actively mining coal in the immediate vicinity. Empire Energy Corporation is mining coal from Wise Hill 5 underground mine and from Williams Fork Strip 1 mine; both of these mines are located approximately 16 miles northeast of the proposed Grace operation. During the initial stage of operations, coal from the Grace mine would be trucked on State Highway 13 past the Empire Energy mines to a loading facility presently planned to be constructed at a railhead south of the Yampa Project generating station. This would avoid further congesting the State highway to Craig, which Empire Energy now uses for truck haulage of their coal.

In addition to the two producing mines, Utah International Incorporated plans to open a new strip mine located approximately 18 miles northeast of the Grace property. The coal from this mine would fuel the Yampa generating station now under construction south of Craig. Grace's mine operation would have little or no effect on the Utah International mine.

Several companies have indicated their intent to conduct mining operations in the vicinity of the W. R. Grace property within the next few years. Utah International holds two Federal leases located one mile northwest of the Grace lease. No plans are currently known for mining of these leases, but Utah International is conducting an extensive exploration drilling program to define mining limits and reserves. Consolidation Coal Company holds several Federal leases located 6 to 12 miles south of the Grace property. Exploration work is being conducted on these leases in anticipation of opening a large underground mine. Paul S. Coupey plans to open a small surface mine in 1976 in this same area. Mining of coal by Grace would have little effect on any of these operations.

The construction of a railroad spur to serve the Grace mine would be a necessity if the mine is to meet its scheduled production requirements. It is possible that this spur might in the future serve some of the other coal developments already identified, as well as the Grace-mined coal.

Two existing and one proposed transmission lines pass through the W. R. Grace lease or within the immediate vicinity. A 69-kv transmission line currently parallels Colorado State Highway 13 along the east side of Grace's Federal lease. The 138-kv Meeker-Axial-Craig transmission line passes through the middle of the lease. Grace would receive power from both of these lines. The proposed 230/345-kv Colorado Ute Craig-Rifle substation transmission line would pass along the west lease boundary. The 138-kv line is the only one which could conceivably interfere with mining operations. Should this happen, W. R. Grace would assist Colorado Ute in moving the line to the 230/345 kv Craig-Rifle right-of-way on the west side of the lease.

Chapter II

Description of the Environment

THE FOLLOWING SECTION DESCRIBES THE PHYSICAL, BIOLOGICAL, AND CULTURAL RESOURCE VALUES WHICH CONSTITUTE THE SITE-SPECIFIC ENVIRONMENT IN WHICH W. R. GRACE AND COMPANY PROPOSES TO DEVELOP FEDERAL COAL. ALTERATIONS OF THESE EXISTING RESOURCE VALUES WOULD RESULT FROM THE IMPLEMENTATION OF THE COMPANY'S PROPOSAL. ADDITIONAL EMPHASIS IS GIVEN TO A DESCRIPTION OF THOSE ENVIRONMENTAL COMPONENTS WHICH MAY BE IMPACTED BY ALTERNATIVES TO W. R. GRACE AND COMPANY'S PROPOSED ACTION DESCRIBED IN CHAPTER VIII.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

Non-living Components

Geologic and Geographic Setting

Topography

The site of W. R. Grace's proposed mine is on the northern slopes of Danforth Hills, and overlooks the topographic Axial Basin to the north (Figure GII-1). The site lies just west of Good Spring Creek. Colorado Highway 13 (789) from Craig to Meeker runs along this canyon.

Good Spring Creek drains northerly past the small townsite of Axial and then into Axial Basin where it joins Milk Creek. Wilson Creek flows northeasterly near the west edge of the site, then across Axial Basin to join Milk Creek where the latter enters its canyon between Iles and Duffy Mountains. The eastern part of the site is drained by Streeter Creek and other small intermittent tributaries to Good Spring Creek. The western part is drained mostly by Taylor Creek, an intermittent stream which flows northeasterly to join Wilson Creek in Axial Basin.

Elevation of the mine site ranges from about 7,640 feet near the southwest corner to 6,560 feet near the northeast corner where Streeter Creek joins Good Spring Creek.

Most of the area is a moderately high, northward-sloping upland ranging from about 7,000-7,600 feet in elevation, and with a relief of generally about 300-500 feet/mile. Valleys cut into this surface by the streams described above are mostly narrow, V-shaped, and about 250-500 feet deep; they slope from about 200 vertical feet/500 horizontal feet (40 percent grade), to 200 vertical feet/200 horizontal feet (100 percent grade).

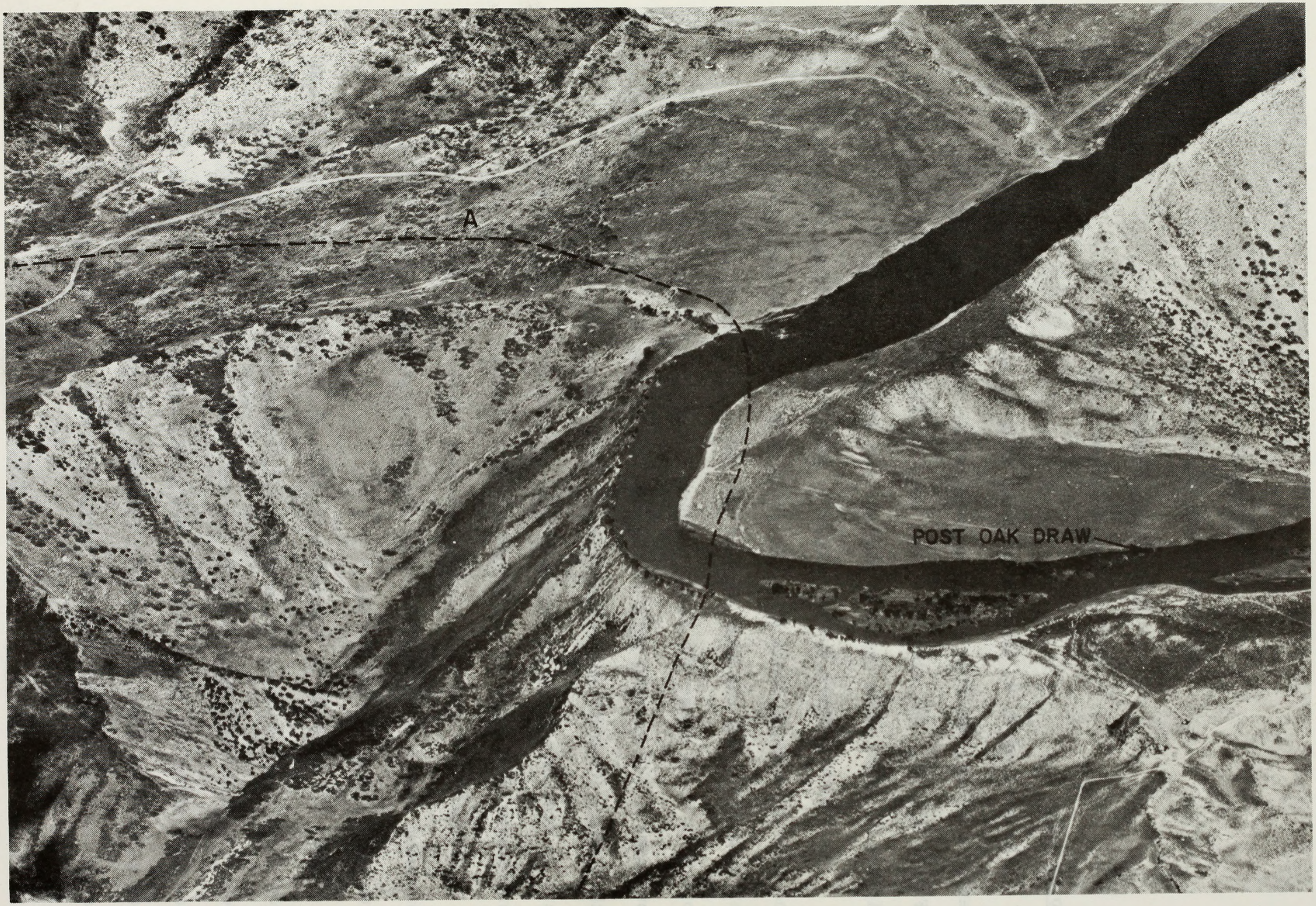


FIGURE GII-1

Aerial oblique photograph, view northeast, showing W.R.Grace Company's proposed mine site in the Danforth Hills.

The steepest slopes are along the west side of Good Spring Creek, north and south of the mouth of Streeter Creek valley, at the east edge of the proposed mine area.

North of the proposed mine site, the surface is mainly two ridgelines about two miles long, trending north-northeast, bounded by Good Spring, Taylor and Wilson Creeks. The surface on each of these ridges slopes down toward the north except for a fairly prominent hill (70 and 130 feet high) on each, about one mile from the Axial Basin. Elevation where these ridges merge with this basin is about 6,400-6,600 feet.

Stratigraphy

Except for surficial deposits, only the coal-bearing Williams Fork Formation is at the surface in the proposed mine area. The underlying Iles Formation, which also has coal beds, crops out at the northeast edge of Sections 26 and 35, and at the north end of the long ridges mentioned before, at the edge of the Axial Basin. The underlying Mancos Shale, about 5,600 feet thick, forms surface bedrock of Axial Basin. Below the Mancos shale, roughly 7,000 feet of sedimentary strata down through beds of Cambrian age overlie the Precambrian (Figure GII-2).

The Williams Fork Formation consists of alternating beds of sandstone, sandy shale, carbonaceous shale, and coal beds; most beds are a few inches to a few feet thick. The formation "is characterized by thick zones of brick-red sandstone and baked shale produced by the burning of large beds of coal" (Hancock 1925). Sandstone beds are mostly fine to medium grained, white to light yellowish brown, and partly to mostly calcareous. Some are friable but most are relatively hard; they range from platy thin-bedded layers to massive cliff-forming beds. Most have fair to good porosity and

ERA	PERIOD	TIME ($\times 10^6$ yrs ago)	GROUP	FORMATION	MEMBER	SUMMARY LITHOLOGIC DESCRIPTION	APPROXIMATE THICKNESS IN FEET UNIT	APPROXIMATE THICKNESS IN FEET CUMULATIVE
MESOZOIC	Cretaceous Upper	70	Mesa Verde Group	Williams Fork Formation		Alternating sandstone, sandy shele, carbonaceous shale, and coal beda; charecterized by brick-red color.	1000	1000
				Iles Formation	Trout Creek SS member	Sendstone, white, fine-greined, well eorted, massive, feirly uniform in thickness.	100	1100
						Alternating beds of massive sandstone and sandy or carbonaceous shale; light brown to white, poorly sorted, generelly calcereous, grades into coel.	1300	2400
				Mancoa Shale		Cley shale; soft dark-gray to drab, with lenses end interbeds of sandstone as much es 75 feet thick. Basal unit of bluish and dark-gray slety shale and celcareous sandstone.	5600	8000
		unconformity		Dakote Sandstone (?)		Quartzitic sandstone; thinly banded greenish-grey, with pebbles at the base.	260	8260
	Jurassic Upper			Morrison Formation		Shale, limestone, chert, conglomerete lenses, and sandstone; grean, greenish-gray, varicolored and maroon.	400	8660
			San Rafael Group	Curtis Formation		Shale, gleuconite sandstone and thin beds of gleuconitic limestone, locally oolitic, thinly-bedded, grey.	40	8700
		unconformity		Entrada Formaties		Sandstone; maseive beds, fine-greined, sugery, light grey.	400	9100
	Triassic Upper			Chinle Formation		Calcareous shale, mudstone and e few sandstone and limeetone pellet conglomerete beds.	350	9450
		unconformity		Shinarump Conglomerete		Sandstone end conglomerete interbedded, lenticuler beds and steeply crossbedded, red.	50	9500
	Triassic Lower	225		Moenkopi Formation		Siltstone, ahale; greenish-grey and grey, with thin red colored beds.	600	10100
PALEOZOIC	Permian	270		Phosphorie Formation		Calcareous shale to sandstone, limestone, and chart with concretions.	100	10200
	Pennsylvanian			Weber Sandstone		Calcareous sandstone; massive, light grey to buff, fine-grained.	250	10450
				Maroon Formetion		Shale, sandstone, and limestone; red, interbedded.	1150	11600
				Paredox Formation		Gypsum, dark ehala, yellow sandetone, red shale and siltstone; thick beds.	650	12250
		unconformity		Morgan Formation		Cherty sandstone, shale and limestone.	1750	14000
				Molas (?)		Besal red shale of Morgan Formation.	50	14050
	Mississippian ? · – ?	350?		Madison Limestone		Cherty dolomitic limestone and dolomite; light and dark grey.	430	14480
	?	unconformity		Beds of undetermined ege		Interbedded shale sandstone, limestone an dolomite.	200	14680
	Cambrian	570		Sawatch Quartzite		Dolomitic quartzite to quartzose sandstone; dark to very light brown and grey, locally crossbedded.	?	?

FIGURE GII-2

Generalized stratigraphic column of rocks underlying W.R. Grace Company's proposed mine site.

SOURCE: Environmental impact report by VTN for W.R. Grace Company permeability. Iron oxide (limonite) locally is present. Shale beds are gray to dark brown; some are carbonaceous; most are sandy, and most weather to small soft chips. There are ten known persistent coal beds in a 392-foot interval of the formation in the proposed mine area. Their aggregate thickness is given by the company as 59.4 feet, and they range in thickness from about two and one-half feet to more than 14 feet and are from 14-80 feet apart. According to the company, at least four deeper coal beds ranging up to 28 feet in thickness occur in a 140-foot thick interval at and below the company's Red Wing mine. The thickness of the Williams Fork Formation in the area is probably about 800 feet. Lauman (1965) measured 1,702 feet in Sections 30 and 31, T.6N., R.91W., and Sections 25 and 36, T.6N., R.92W., approximately 12 miles north of the proposed mine site. About 900 feet of the upper part of the formation has been removed by erosion from the proposed mine site.

Much of the surface of the upland area is covered by a variable thickness of residuum and soils, perhaps as much as five feet or more in thickness. Some slightly thicker alluvial deposits of silt and sand may also be present here. Slopes leading down from the upland to the valley bottoms have variable thicknesses of slope wash materials. In a cut into the thick X coal bed in SW 1/4, Section 2, T.3N., R.93W., 7-14 feet of slopewash lies on a fairly steep slope. This material includes discontinuous layers of sandstone fragments up to one foot thick and individual pieces of sandstone randomly mixed with unsorted materials consisting largely of silt and sand with lesser amounts of clay. Minor draws on these hillsides and the main stream valleys have perhaps 10-20 feet of light to dark brown clayey alluvium and colluvium.

Structure

The proposed mine site lies about six miles south of the axis of Axial Basin anticline, a large west-northwesterly-trending fold. The axis of a parallel subsidiary fold, Collom syncline, trends southeasterly through the northeast part of the site. North of this axis, beds of Williams Fork Formation dip toward the south more steeply outside the site area (8-30°) and more gently inside. South of the axis of Collom syncline, throughout most of the site area, beds dip about three to ten degrees northerly. The company report mentions linear patterns on aerial photographs that indicate either faults or joints. Three major joint trends are reported by the company; these are near-vertical to vertical and strike about N.70°W., N.45°W., and N.30°E.

Geomorphology

Northward-sloping high ridges of the proposed mine site and vicinity are underlain by beds of the Williams Fork Formation which dip in the same direction and at approximately the same degree as the land surface. North of the axis of the Collom syncline, the two prominent hills near the northern end of two of these ridges (Sections 27 and 28, T.4N., R.93W.) are the result of greater resistance to erosion offered by upturned edges of several hard steeply south-dipping beds of sandstone.

Hard sandstone beds have caused narrow V-shaped stream valleys with moderately steep to precipitous slopes a few hundred to several hundred feet high. Wilson, Taylor, and upper Streeter Creeks flow in straight narrow valleys which trend about N.30°E., the same as one of the joint trends. Wilson and Taylor Creeks in particular, may run along small straight normal faults which are part of this N.30°E. fracture set. This possibility is indicated by the slight difference in strike of the beds on opposite sides of Taylor Creek, as shown on the company's geologic map (Section 4, T.3N., R.93W.; Section 33, T.4N., R.93W.).

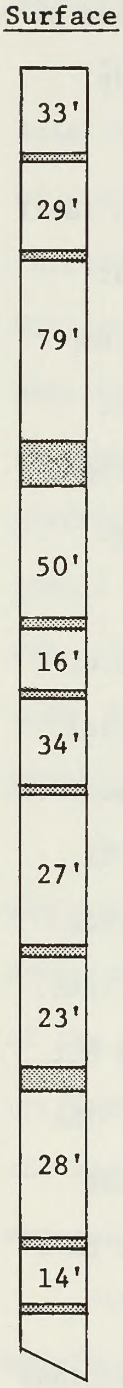
The combination of dip slopes and steep valley sides provides an ideal setting for landslide forms although no specific ones have been noted. Slightly hummocky terrain raises the possibility of small slide or slump features. The small anticline and syncline shown in SW 1/4 Section 2, T.3N., R.93W. on the company map may, in the absence of more information, be considered to be possibly of landslide rather than tectonic origin.

Overburden

The overburden consists mainly of alternating hard and soft beds of the Williams Fork Formation, as described under Stratigraphy. Surficial materials, alluvium and residuum, form a thin layer above the bedrock.

Four cross-sections by the company, in Sections 2, 3 and NW 1/4 11, T.3N., R.93W., show that overburden thickness above the top (X) main bed is mostly in the range of 100-150 feet with a maximum of perhaps 200 feet. The overlying Y beds would be about 80-110 feet closer to the surface but were not shown on the sections because of "insufficient drill data". The overburden thins to zero where the X and other coal beds crop out along the valley sides. As each bed is mined, the next lower coal bed will have an overburden of approximately the thickness shown on Figure GII-3.

Measurements at 28 evenly spaced points along the three cross-sections showed a total average thickness of about 320 feet to be mined, including coal beds.



Coal Bed	Thickness (feet)	Tons (millions)	BTU (per pound)	Sulfur (%)	Ash (%)	Water (%)
Y3	3.7	3.8	10,149	0.37	4.26	18.56
Y2	3.1	3.2	10,273	0.36	5.40	16.65
X	12.3	34.1	10,553	0.33	5.40	15.48
A2	4.0	7.7	10,672	0.42	4.89	15.29
A3	2.7	5.2	10,311	0.59	8.31	14.65
B1	5.3	15.3	10,780	0.39	4.6	15.09
C	6.0	20.3	10,727	0.33	4.75	14.83
D	10.1	34.2	10,626	0.34	6.27	14.45
E	6.8	23.3	10,984	0.51	4.03	14.54
F	5.4	17.9	10,903	0.57	4.86	14.21
	Total	165.0	10,705	0.4	5.16	14.91
					Averages	

FIGURE GII-3

Coal beds to be mined at proposed W.R. Grace strip mine.

SOURCE: W.R. Grace Company

Paleontology

All mining activity at the Colowyo mine site will occur in the Williams Fork Formation of the Mesaverde Group. Many fossil imprints may be found in the coal seams, largely ammonites (flat coiled seashells), generally valuable as index fossils. No sites were located in the paleontological survey of Federal coal lease D-034365, completed by Dr. Peter Robinson of the University of Colorado Museum.

Mineral Resources

Coal

The coal beds of interest at this proposed mine site are in the Williams Fork Formation. Hancock (1925) designated this as the "Fairfield or principal group of coal beds". These coal beds occur above the Trout Creek Sandstone Member, the top unit of the Iles Formation. Hancock (1925) states that "The Black Diamond group of coal beds, which occurs locally from 200 to 400 feet below the Trout Creek sandstone and which is of considerable value near Meeker, Colorado, is represented in the vicinity of Axial Basin by a few thin beds of coal of very little economic importance and accordingly was not taken into account in the estimation of tonnage". Thus the coal beds described hereafter are presumably the only ones of potential economic interest here.

Data from the company indicate the occurrence of ten coal beds ranging in average thickness from 2.7-12.3 feet (Figure GII-3). The X seam is known to be as much as 14 feet thick from one cut made in SW 1/4 Section 2, T.3N., R.93W. The company regards these as eight beds of coal, as shown by their lettering (Y3 and Y2 as one bed; A2 and A3 as one bed). However their cross-sections show these as individual beds, rather than splits from one bed, within the proposed mine area.

The company reports four deeper coal beds in the Williams Fork Formation that can be mined later by underground methods. They report that at least one of these, the bed in their now inactive underground Red Wing Mine (formerly Streeter Mine), is 27 feet thick. Hancock (1925) shows a measured outcrop thickness of 20 feet for this bed, and also indicates another plus-20 foot bed about 60 feet lower stratigraphically. Hancock (1925) also notes a lower coal bed nearby measured at 27 feet thick, in SW 1/4 NE 1/4 SE 1/4 Section 35, T.4N., R.93W. He believed this "bed is probably about 350 feet above the Trout Creek Sandstone".

In the absence of a single drill hole log showing the numerous coal beds of this general area, a composite stratigraphic section is shown in Figure GII-4. This figure is from Hancock's careful surface measurements (1925) and a few measurements in old mines; numbers on the right side of the column show coal bed thickness and numbers on the left are Hancock's locality numbers, details of which may be checked in his report. Approximate stratigraphic interval of beds to be stripped and beds that may be mined underground are indicated. Hancock's figure may not show all coal beds that are present, because of the poor exposure due to slope-wash, burned beds, diverse dip of the beds, and consequent difficulty of tracing beds. Also the interbed intervals may not be precise because of the difficulty in making accurate surface measurements in these folded beds.

Recoverable reserves of the coal to be mined by surface methods are stated by the company as 165 million short tons, based on a 90 percent recovery rate; approximately 18 million short tons would be lost in the

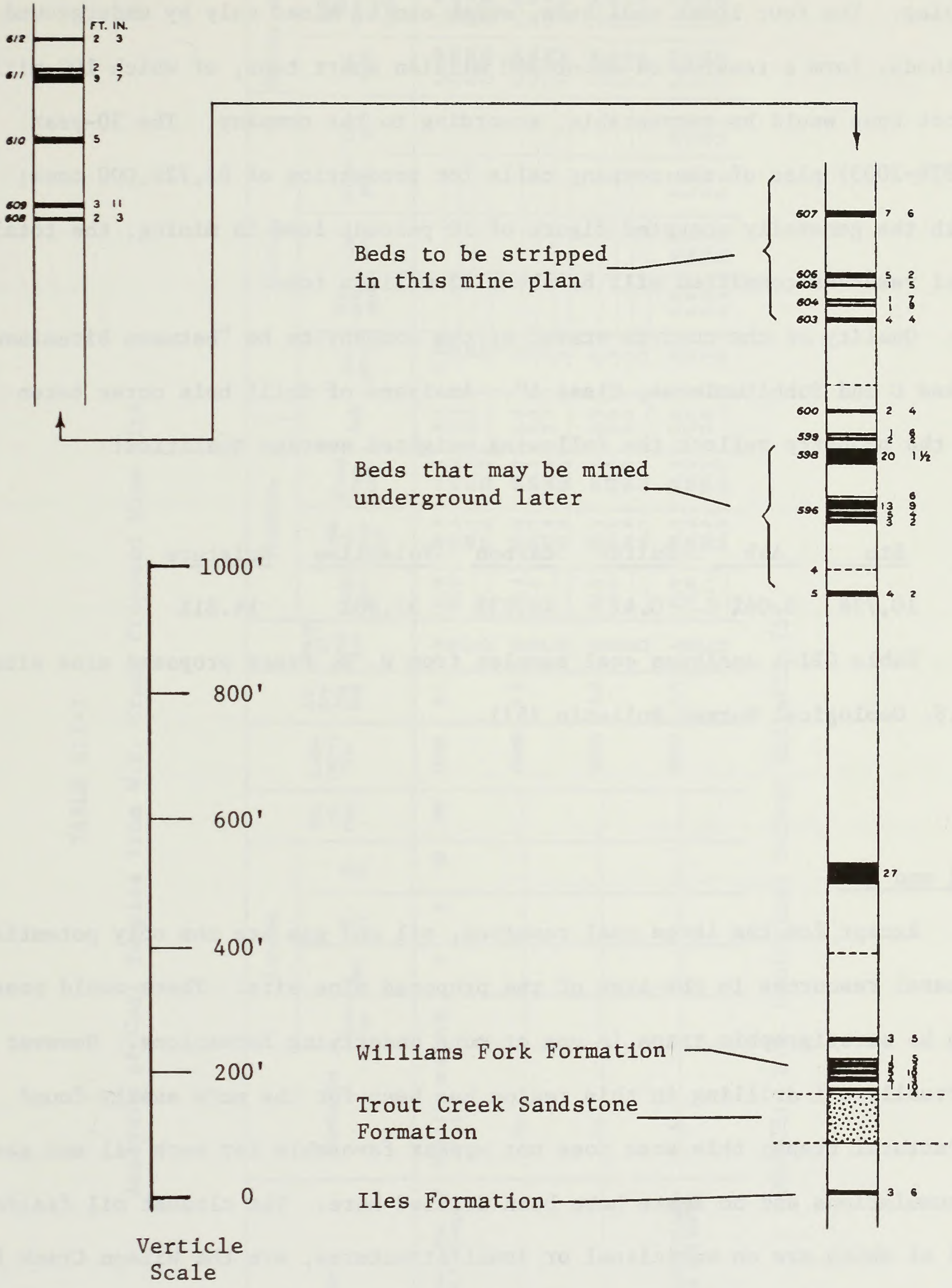


FIGURE GII-4

Stratigraphic position of coal beds at W.R. Grace proposed mine site.

SOURCE: U.S. Geological Survey Bulletin 757 mining. The four lower coal beds, which can be mined only by underground methods, form a reserve of about 200 million short tons, of which 100 million short tons would be recoverable, according to the company. The 30-year (1976-2005) plan of the company calls for production of 83,720,000 tons; with the generally accepted figure of 10 percent loss in mining, the total coal reserves committed will be about 93 million tons.

Quality of the coal is stated by the company to be "between Bituminous, Class C and Subbituminous, Class A". Analyses of drill hole cores taken on the property reflect the following weighted average qualities:

Btu	Ash	Sulfur	Carbon	Volatiles	Moisture
10,728	5.06%	0.4%	46.23%	33.90%	14.81%

Table GII-1 analyzes coal samples from W. R. Grace proposed mine site (U.S. Geological Survey Bulletin 757).

Oil and gas

Except for the large coal reserves, oil and gas are the only potential mineral resources in the area of the proposed mine site. There could possibly be stratigraphic traps in one or more underlying formations. However virtually all drilling in this region has been for the more easily found structural traps; this area does not appear favorable for such oil and gas accumulations and no tests have been drilled here. The closest oil fields, all of which are on anticlinal or domal structures, are the Wilson Creek field about five miles to the southwest, the Iles Dome oil field about six miles northeast, and the Thornburgh Dome field about seven miles east-southeast.

TABLE GII-1

Analysis of Coal Samples from W.R. Grace Proposed Mine Site

Mine	Formation	Location				No. on map	Laboratory No.	Air-drying loss	Form of analysis	Proximate				Ultimate					Heating value	
		Quarter	Sec.	T. N.	R. W.					Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	British thermal units
Mount Streeter No. 10 mine (Joseph Collom).	Williams Fork.	NE.	2	3	93	598	14543	2.1	A	11.9	[a]40.6	45.3	2.2	0.32	......	......	......	......	6,450	11,610
									B	10.0	41.5	46.2	2.3	.33	......	......	......	......	6,590	11,860
									C	......	46.1	51.4	2.5	.36	......	......	......	......	7,325	13,180
									D	......	47.3	52.7	......	.37	......	......	......	......	7,510	13,520
Do	do	......	......	......	......	......	93309	1.8	A	10.4	38.0	49.2	2.4	.3	......	......	......	......	6,570	11,820
									B	8.8	38.7	50.1	2.4	.3	......	......	......	......	6,685	12,030
									C	......	42.4	54.9	2.7	.3	......	......	......	......	7,320	13,180
									D	......	43.5	56.5	......	.3	......	......	......	......	7,520	13,540
Do	do	......	......	......	......	......	93310	1.7	A	10.2	40.1	46.9	2.8	.3	......	......	......	......	6,570	11,830
									B	8.6	40.8	47.7	2.9	.3	......	......	......	......	6,685	12,030
									C	......	44.6	52.3	3.1	.3	......	......	......	......	7,320	13,170
									D	......	46.1	53.9	......	.3	......	......	......	......	7,550	13,590
Do. (composite of samples 93309 and 93310).	do	......	......	......	......	......	93311	1.7	A	10.6	38.5	48.4	2.5	.2	5.9	66.8	1.2	23.4	6,570	11,830
									B	9.0	39.2	49.2	2.6	.3	5.8	68.0	1.2	22.1	6,690	12,040
									C	......	43.1	54.1	2.8	.3	5.3	74.7	1.4	15.5	7,350	13,230
									D	......	44.3	55.7	......	.3	5.4	76.8	1.4	16.1	7,560	13,610

SOURCE: U.S. Geological Survey Bulletin 757

Water Resources

Ground water

Rocks at Colowyo Mine dip northeastward toward Streeter Creek. All of the coal beds to be mined are truncated by the valleys of Streeter Creek on the north and Good Spring Creek on the east. As a result these beds are all drained, except for local perching. Local perching produced some downward cascading of water in some of the test holes; however no saturation was encountered in any of the beds that are to be mined.

Recharge takes place throughout the area but is largely confined to the valleys of the ephemeral upland water courses such as Streeter Creek and its tributaries; most of the areas of perched water occur beneath these valleys. The perched water gradually moves downward to the main level of saturation which is probably near the level of Good Spring Creek. A small amount of perched ground water discharges into Streeter Creek. The remainder of the ground water that is recharged in the area is discharged to Good Spring Creek.

Surface water - quantity and quality

Drainage and stream flow characteristics

Colowyo Mine Company property is drained by tributaries of Milk Creek which is a tributary of the Yampa River. The downstream and tributary order of the drainage system is indicated below:

- Yampa River
  - Milk Creek
    - Good Spring Creek
      - Streeter Creek
    - Wilson Creek
      - Taylor Creek
      - Jubb Creek

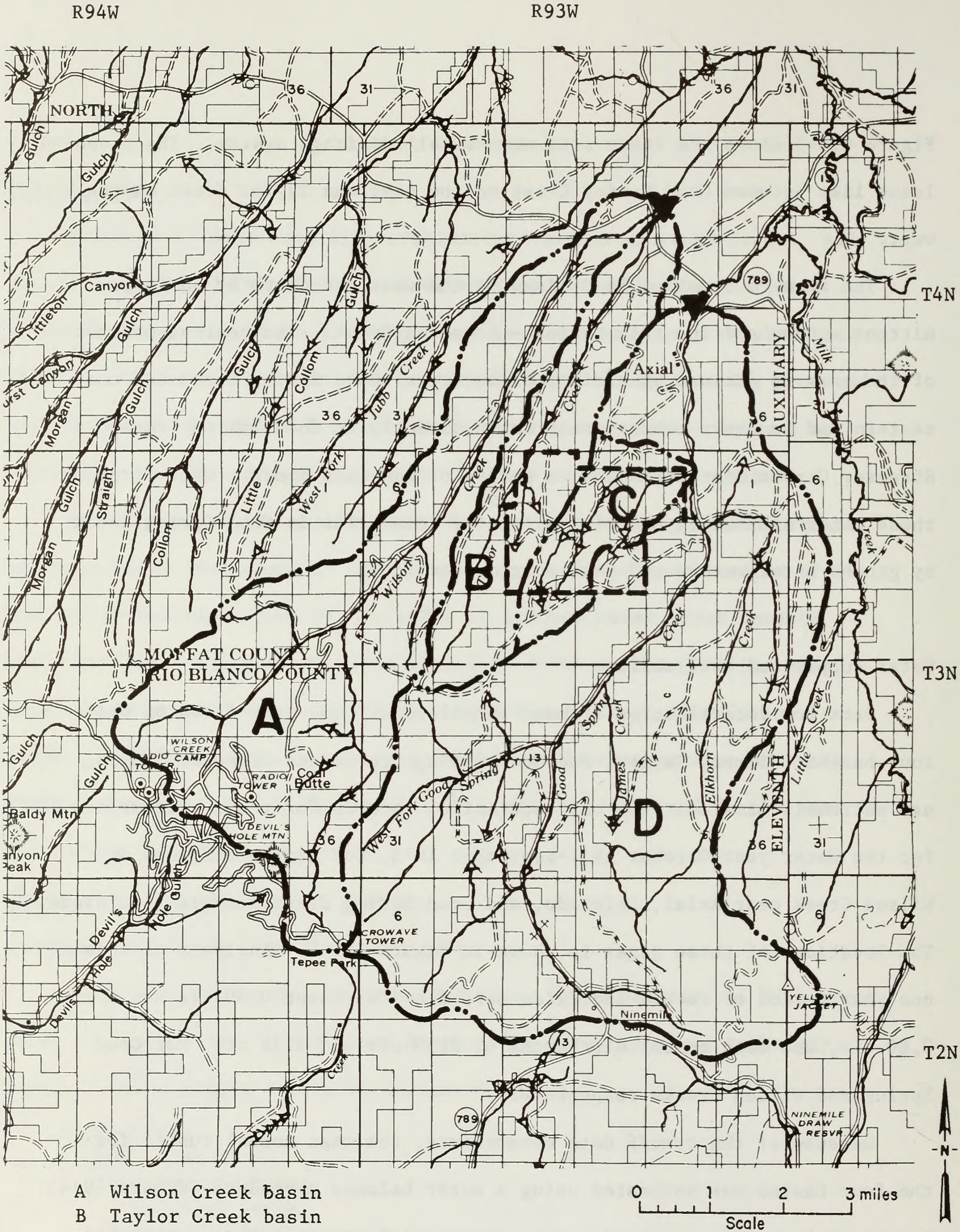
Figure GII-5 shows the lease area and overall drainage system. The proposed lease lies between Good Spring Creek on the east and Taylor Creek on the west.

The area to be mined is drained on the west and north by an intermittent stream and its tributaries - Streeter Creek. The central portion of the area is drained by a minor tributary of Good Spring Creek and the eastern and southern border areas drain directly to Good Spring Creek. Streeter Canyon discharges into a series of man-made ponds. Water from these ponds ultimately contributes to the total flow in Good Spring Creek by ground water return and pond system overflow.

Water supply and availability

Data for determination of mean annual runoff and peak flows of the four basins; Wilson, Taylor, and Good Spring Creeks and Streeter Canyon, are extremely limited. The only streamflow records for these streams are for the water year October 1974-September 1975, for gaging stations on Wilson Creek near Axial, Colorado, and Good Spring Creek at Axial, Colorado. The locations of these gages is shown in Figure GII-5. Analysis of this one year period of record indicates base flows of about 0.80 cfs and 0.60 cfs, and mean annual discharges of 2.39 cfs and 2.30 cfs, for Good Spring and Wilson Creeks respectively.

Because of the runoff data constraints, the mean annual runoff for the four basins was estimated using a water balance procedure (Wymore 1974). A water balance was computed using estimates of precipitation, available



A Wilson Creek basin
B Taylor Creek basin
C Streeter Creek basin
D Good Spring Creek basin
▼ Stream gage with water samples

FIGURE GII-5

Lease area and overall drainage system.

water holding capacity of soils, and potential and actual evapotranspiration by elevation zones for the major vegetation types in the basins. Evapotranspiration within elevation zones was also adjusted for differences in slope and aspect.

No precipitation data have been collected within the basins; however precipitation data are available for climatic stations at Meeker and Hamilton, Colorado. A precipitation map of Colorado published by the U.S. Weather Bureau (1960) indicates that the Meeker data may be more representative of average precipitation conditions on the basins than the Hamilton data. Therefore the Meeker data were used in the water balance and were adjusted for elevation differences between Meeker and basin sites. Adjustment factors used were those developed by Wymore (1974). Mean monthly and mean annual precipitation for Meeker from 1941 to 1973 are shown in Table GII-2.

TABLE GII-2

Mean Monthly and Mean Annual Precipitation
For Meeker, Colorado, 1941-73

Precipitation, in inches

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.17	1.07	1.39	1.65	1.47	1.45	1.43	1.92	1.29	1.52	1.14	1.39

Annual Average: 16.89

Available water-holding capacities of soils for major vegetation types were determined from discussions from Wymore (1975) and from U.S. Geological Survey (USGS) (R.F. Miller, I.S. McQueen and F. A. Branson).

Potential evapotranspiration was computed using a technique described by Wymore (1974) which requires mean monthly solar radiation and air temperature data. Solar radiation data were obtained from Grand Junction, Colorado, 86 miles southwest; air temperature data were obtained from the climatic station at Meeker, Colorado. Air temperature data were adjusted for differences in elevation between Meeker and the basin sites using adjustment factors developed by Wymore (1974). Actual evapotranspiration was computed as a function of potential evapotranspiration, precipitation, vegetation type, and available soil water.

The results of the water-balance computations for the four basins are shown in Table GII-3. Runoff figures for Good Spring and Wilson Creeks are computed for the existing gage sites (Figure GII-5). Runoff figures for Taylor Creek and Streeter Canyon are computed for the basins' mouths; they may be underestimated for Taylor Creek and Streeter Canyon because ground water recharge occurring in Wilson and Good Spring Basins may appear as discharge in Taylor and Streeter basins. This possibility is not considered in the water balance procedure for Taylor and Streeter Creeks because the procedure treats the basin as a closed system.

TABLE GII-3

Drainage-Basin Areas and Annual Water-Balance Estimates

Basin	Area (mi^2)	Precipitation (inches)	Computed Evapotranspiration (inches)	Estimated Runoff (inches)	Estimated Runoff (acre-feet)
Good Spring Creek	39.45	22.52	21.91	0.61	1,270
Wilson Creek	26.98	22.44	21.42	1.02	1,480
Taylor Creek	7.14	21.50	21.17	.33	125
Streeter Creek	2.12	21.55	21.16	.39	45

As with all water balance computations for areas of low water yield, the probable error in most of the variables entering the water balance may be as large or larger than the predicted runoff values. This is mentioned not to discredit the results, but to remind the reader that these figures are initial estimates to be revised as additional data become available. The computed runoff figures in Table GII-3 appear to be reasonable initial estimates and the procedure used to compute them has worked well in a hydrologically similar basin (Wymore 1974). Additional climatic and hydrologic data from the basins are being collected.

Lack of sufficient runoff data also necessitates the use of empirical techniques to determine peak flows. One such approach, called the index-flood method, is presented by Patterson and Somers (1966) for the Colorado River basin. The index-flood method estimates magnitude and frequency of floods for any recurrence interval from 1.1-50 years using basin characteristics of drainage area and mean altitude. Using flood frequency analyses of 342 gaging-station records and the relationship among the mean annual flood, drainage area, and mean altitude, Colorado River basin was delineated into 23 hydrologic areas. Colorado River basin was also divided into six homogeneous flood frequency regions on the basis of the slopes of the individual frequency curves. This resulted in the definition of six composite frequency curves from which can be derived the ratios of mean annual floods to floods having recurrence intervals of 1.1-50 years. The basins in question fall into hydrologic area 3 and flood-frequency region A. Peak flows in region A are typically snowmelt runoff peaks.

The small basin areas and mean altitudes of Wilson, Taylor, Good Spring and Streeter Creeks cause them to fall outside the range of available data for hydrologic area 3. Estimates of the mean annual flood for Wilson and Good Spring Creeks were extrapolated from the existing data, and for Wilson Creek they are 160 cfs, and for Good Spring Creek, 210 cfs. Using the composite frequency curve for region A and the mean annual flood estimates covered before, the estimated peak discharge for the flood with a recurrence interval of 50 years is 200 cfs for Wilson Creek and 400 cfs for Good Spring Creek. Patterson and Somers (1966) stated that flood frequency ratios can be used with confidence only up to the 50-year recurrence interval; however extending the relationship to obtain an estimate of the 100-year flood for Wilson and Good Spring Creeks gives peak discharges of 340 and 440 cfs respectively. Given available climatic, topographic, vegetative, and soils data, peak flow estimates obtained from the index-flood method appear somewhat high, probably resulting from the extrapolation. These estimates must be considered preliminary, to be revised as more data become available.

The smaller basin area and lower mean altitude of Taylor Creek and Streeter Canyon will probably cause their peak flows to result from high intensity rainfall rather than from snowmelt; the estimated 100-year 1-hour rainfall is 1.5 inches (Hershfield 1961). Peak flows for these basins were computed using the Soil Conservation Service (SCS) triangular unit-hydrograph procedure, and from this storm it is estimated to be 100 cfs for Streeter Canyon, 120 cfs for Taylor Creek, 190 cfs for Wilson Creek, and about 270 cfs for Good Spring Creek.

The results of both the index-flood method and the triangular unit-hydrograph procedure are for natural basin and channel conditions. Existing check dams and other runoff control structures on the basins will alter peak flows from those expected in a natural channel; effects of these structures are not readily entered into either estimation procedure and therefore were not considered.

Quality of streams in the analysis area

Water samples were collected by VTN Colorado Incorporated in the analysis area at nine sampling locations. These samples were analyzed by Rocky Mountain Technology of Golden and Ute Laboratories in Fort Duchesne, Utah.

Table GII-4 presents a complete list of the principal cations and anions for all VTN samples collected during the period August 1974 through January 1975. Data presented in Table GII-5 are average values for all VTN water samples which were analyzed.

General water types found in streams in the analysis area can be assessed from the average values in Table GII-5. Water types are based on their relative ion contents and are a general indication of the source of the water: for example, snow will contain very few soluble salts; however after it has been in contact with soil and rocks, its chemistry will change considerably. The type and magnitude of this change in chemistry

TABLE GII-4

Water Quality Analysis
Colowyo Mine at Mount Streeter, Colorado

Location and Date		pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	F	B	SiO_2	TDS	Alka-linity	SC
Taylor Creek I -	Aug. '74	8.4	95	52	21	5	23	475	58	13	13	0.1	0.4	750	428	740^L
	Sept.	-	49	38	10	3	1	281	90	14	0.4	-	8.2	445	230	630^L
	Oct.	-	78	54	60	5	1	257	94.4	3.9	0.1	-	8.0	513	-	800^F
Taylor Creek II -	Aug.	8.6	56	96	68	10	48	567	110	28	0.5	1.0	.91	1050	545	1125^L
	Sept.	-	37	93	71	10	1	440	250	26	0.9	-	5.7	799	361	1120^L
	Oct.	-	169	113	130	16	1	364	278	7.0	0.2	-	6.5	888	-	1350^F
Good Spring Creek I -	Sept.		85	111	40	11	1	458	390	17	0.6		8.7	1037	375	1290^L
	Oct.		107	113	226	20	1	389	378	3.5	0.3		6.5	1056		1550^F
	Nov.		121	128	32	5.3	1	281	410	4.0	1.0	0.23		1255		
Good Spring Creek II -	Aug.	8.5	110	110	48	13	42	769	130	13	.52	0.30	1.4	1260	700	1190^L
	Sept.		85	122	52	11	1	506	440	19	0.7		7.6	1109	415	1380^L
	Oct.		113	132	88	10	1	390	456	3.7	0.5		6.6	1073		1600^F
	Nov.		118	124	48	7.2	1	333	497	4.0	0.4	0.24	1	1010		
	Dec.		93	71	111	5	1	470	333	122	1.5			1012		
	Jan.		104	150	60	7.6	36	446	600	8.5	0.6		0.72	840	482	
Good Spring Creek III -	Aug.	8.5	100	140	64	17	15	854	190	14	0.59	0.25	1.3	1440	775	1410^L
	Sept.							--None--								
	Oct.		100	148	116	10	1	437	467	4.7	0.4		6.6	1220		1800^F
	Nov.		129	131	49	7.2	1	356	407	4.3	1.5	0.24	1	1173		
	Dec.		112	126	44	6.7	1	571	560	17	1.3		11.7	1129		
	Jan.		106	153	62	8.3	32	472	620	6.0	0.9		1.1	1040	504	
Wilson Creek I -	Oct.		100	76	180	12	1	394	467	25.9	0.4		10.1	975		1330^F
	Nov.		112	53	113	3.1	1	318	136	24	1.0	0.14	1	835		
Wilson Creek II -	Aug.	8.4	90	64	120	11	26	580	85	120	0.6	0.15	1.6	1130	515	1340^L
	Sept.		73	54	108	9	1	395	160	116	0.5		9.4	876	324	1280^L
	Oct.		113	88	180	8	1	336	222	30	0.5		9.1	1108		1800^F
	Nov.		124	77	132	10	1		223	29.1	0.9	0.19		2021		
	Dec.		93	71	111	5	1	470	333	122	1.5			1012		
	Jan.		102	98	126	7	0		450	8.5	0.9		2.2	920	1280	
Wilson Creek III -	Aug.	8.5	78	88	150	12	36	647	120	140	0.6	0.15	0.9	1320	590	1530^L
	Sept.		85	87	148	10	1	425	300	146	0.5		7.0	1135	348	1640^L
	Oct.		82	113	188	5	1	426	378	35.4	0.4		8.3	1295		2050^F (1600^L)
	Nov.		119	113	158	7	1	322	325	34.6	1.4	0.24		808		
	Dec.		Taylor Creek Dry -- Wilson III same as Composite													
Composite	Aug.						--No Data--									
	Sept.		61	87	145	10	1	425	250	156	0.5		6.6	1079	348	1570^L
	Oct.		75	116	180	4	1	390	422	35.1	0.4		8.0	1326		2100^F (1580^L)
	Nov.		Same as Wilson Creek III -- Taylor not flowing													
	Dec.		101	90	127	6	1	542	426	138	1.0		13.4	1092		
	Jan.		98	119	137	8	20	426	493	11.0	0.8		0.6	960	466	

SOURCE: Modified Mining Plan, Colowyo Coal Mine, Colowyo Coal Company, April 30, 1975.

L,F Laboratory or field valves

TABLE GII-5

Average Concentrations All Samples

Location	pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	F	B	SiO_2	TDS	Hardness $CaCO_3$	SC
Taylor Creek I	8.4	74	48	30	4.3	23	338	81	10.3	4.5	0.1	5.5	569	329	723
II	8.6	87	101	90	13.0	48	457	213	20.3	0.5	1.0	4.4	912	302	1198
Good Spring Creek I	-	104	117	99	12.1	1	376	393	8.2	0.6	0.23	7.6	1116	375	
II	8.5	107	107	47	7.6	39	430	378	9.1	0.5	0.37	4.2	1067	532	
III	8.5	109	140	67	9.8	38	538	449	10.0	0.9	0.25	4.5	1200	640	
Wilson Creek I		106	64	146	7.6	1	356	91	25.0	0.7	0.14	5.6	905		
II	8.4	100	75	130	8.3	26	445	246	83.4	0.8	0.17	5.6	1179	706	
III[1]	8.5	94	102	151	8.0	28	465	340	98.0	0.8	0.21	5.9	1102	468	
Composite I[2]		68	102	162	7.0	1	408	383	95.5	0.4		7.3	1053	348	

[1] Includes Dec. and Jan. of composite since Taylor Creek not flowing.

[2] Sept. and Oct. only.

SOURCE: Modified Mining Plan, Colowyo Coal Mine, Colowyo Coal Company, April 30, 1975.

depends primarily upon the local soil and rock chemistry. Water types in the vicinity of proposed mining activity are (Grace 1975):

Location		Water Type
Taylor Creek	I	Ca - HCO_3
	II	Mg - HCO_3
Good Spring Creek	I	Mg - SO_4, HCO_3
	II	Mg, Ca - HCO_3, SO_4
	III	Mg - HCO_3, SO_4
Wilson Creek	I	Na - HCO_3
	II	Na - HCO_3, SO_4
	III	Na - HCO_3, SO_4
Composite	I	Na - HCO_3, SO_4

These water types may be summarized as typical calcium (Ca) or magnesium (Mg) bicarbonate (HCO_3) near the headwaters of the streams, with a gradual exchange of calcium and magnesium for sodium (Na) in a downstream direction. Concentration of sulfate (SO_4) also becomes more dominant in the downstream reaches. These samples were taken during the time of year when the water occurring in the streams is largely the result of base flow (i.e., that portion of the stream flow which is supported by seeps and springs in the absence of snowmelt or rain). Water chemistry would most nearly resemble rock chemistry during this time of the year. Flows and chemistry of streams during spring runoff would provide information on the opposite end of the spectrum.

Figure GII-6 (Grace 1975) is a graphical representation of the change in water chemistry with time for three of the VTN sampling stations. The only consistent relationship among the three stations is the SO_4 ion concentration which tends to increase throughout the period of record.

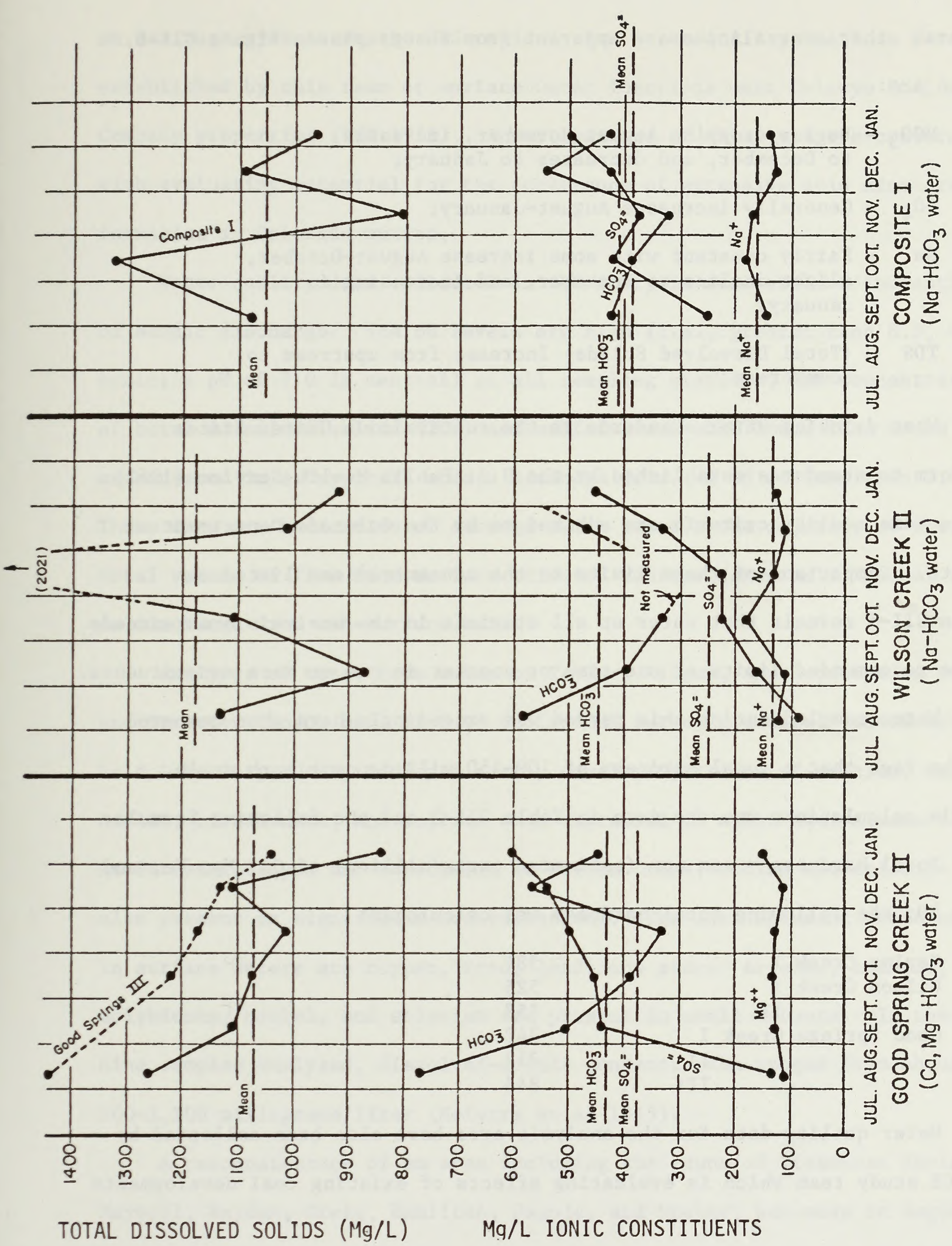


FIGURE GII-6

Selected ion concentrations and TDS.

Several other generalities are apparent from the graphs in Figure GII-6. These are:

HCO_3 - Begins dropping August-November, increases to December, and decreases to January;

SO_4 - Generally increases August-January;

Na - Fairly constant with some increase August-October, slight decline to December, and increasing in January;

TDS - (Total Dissolved Solids) Increase from upstream to downstream.

Most drinking water standards in the conterminous United States conform to standards established by the U.S. Public Health Service (1962). These same quality criteria are adhered to by the Colorado Department of Health. Comparison of these limits to the concentrations listed on Table GII-5 reveals that water at all stations in the analysis area exceeds these recommended limits at one time or another in one or more constituents.

Water sampled during this period was exceedingly hard when compared to the fact that a total hardness of 100-150 will deposit much scale. Sample calculations use the data in Table GII-5 and the following formula:

Total hardness = sum epm (estimated parts/million) of Ca, Mg, Fe, and Mn x 50; the following total hardness was calculated:

Taylor Creek	I	384
Wilson Creek	I	526
	II	558
Good Springs Creek	I	742
	II	712
	III	846

Water quality data for the analysis area have also been collected by a USGS study team which is evaluating effects of existing coal developments on drainage systems in the EIS region. Two water quality stations were established by this team at surface water locations near Colowyo Coal Company properties (VTN 1975). Investigations of this type are concerned with evaluating potential for the occurrence of extensive acid mine drainage formation in Colorado waters.

Water quality data collected in the analysis area are not indicative of acidic discharge. The pH levels are high (i.e., greater than 8.0, very basic; a pH of 7.0 is neutral) at all sampling stations, and concentrations of total dissolved solids (TDS) and sulfates are much lower than would be encountered in a "typical" acidic drainage (i.e., a pH of less than 7.0). These data are indicative of streams which receive the majority of their total volume of flow from surface oriented sources (snow melt) rather than as discharge from sub-surface water.

Analyses of water from sites on Taylor, Wilson, and Good Spring Creeks and Streeter Canyon made at U.S. Geological Survey's central laboratory in Salt Lake City, Utah, indicate nearly equal proportions of calcium, magnesium, bicarbonate, and sulfate when expressed in milli-equivalents/liter. At Streeter Canyon and especially at Wilson Creek, sodium and chloride are also present in significant concentrations. The most abundant trace metals in surface waters are copper, iron, lead, and zinc. Arsenic, cadmium, molybdenum, nickel, and selenium are present in small amounts. In the nine samples analyzed, dissolved-solids concentration ranged from about 500-1,100 milligrams/liter (Hofstra et al 1975).

A reconnaissance of an area including the towns of Steamboat Springs, Maybell, Hayden, Craig, Hamilton, Pagoda, and Meeker, was made in August 1974

(Hofstra et al 1975). Specific-conductance measurements were made at streams and springs in the area to determine the normal dissolved-solids concentration of waters discharged through springs and ground water inflow from Williams Fork, Iles, and Mancos Formations. A conductance range from about 600-2,400 micromhos/centimeter at 25°C was observed in streams draining these formations, with the most common range from 900-1,200 micromhos. Analyses made in this study show specific conductance can be converted to the approximate dissolved-solids content in milligrams/liter by taking 60 percent of conductance value. Conductance values of about 600 micromhos/centimeter were measured at springs, and near the headwater of Taylor Creek on the Grace tract, the project study site. Dissolved solids increase downstream on all streams, mostly due to inflow of higher salinity ground water.

Physical nature of streams

Streams in the analysis area are characterized by meandering channels and low velocity flows. The banks of Good Spring Creek are steep and undercut in many locations. Local riparian vegetation is composed of low velocity flows. The banks of Good Spring Creek are steep and undercut in many locations. Local riparian vegetation is composed of low growing grasses, sedges, and rushes with an occasional willow providing the only significant streamside cover.

Water and related land resource problems in the analysis area

The Colorado Land Use Commission has classified the general region encompassing Colowyo Mine property boundaries as contributing a low yield of dissolved and suspended sediments to the overall stream system (VTN 1975). Of all the streams in the general area, Wilson Creek exhibits the greatest amount of erosion. Less riparian vegetation is found on the slopes adjacent to this stream system than along the other drainages in the analysis area. The heaviest erosion of Wilson Creek is confined to particular sections of the stream channel. A dramatic cyclical pattern of deposition, erosion, and further deposition is observed along the course of this stream adjacent to the analysis area (Grace 1975).

There are several small man-made impoundments which affect the stream flow in the proposed mining area. These reservoirs have a capacity of less than one-half acre-foot and are used to provide normal water supplies for livestock. Four of the stock ponds, two on Taylor Creek and two near the headwaters of Streeter Canyon, exceed one acre-foot capacity.

Access road construction on the 4.1 square miles of property currently earmarked for mining development has resulted in alterations to traditional flow patterns at various points along the drainage courses of Streeter and Taylor Creeks. During spring runoff, ephemeral springs and creeks are often seen flowing along and across unpaved road surfaces, resulting in accelerated erosion and higher downstream turbidities.

The two existing underground mines, Red Wing and Streeter, do not affect water resources. Both of these mines have been closed to production, due to a fire in the coal seam and the associated production of carbon monoxide gas in the shafts.

Climate

The Colowyo Mine is located within the Axial Basin about three kilometers (two miles) southwest of the Town of Axial and about one kilometer (0.5 miles) west of State Highway 13. The Axial Basin is bounded to the south by the Dansforth Hills which extend to elevations greater than 2,700 meters (9,000 feet). The mine site elevation varies from 2,300 meters (7,500 feet) near the southern boundary to 2,100 meters (6,900 feet) at the northern edge.

Several deep canyons within the mine lease boundary influence climatic conditions. The western portion is out by Taylor Creek Canyon which extends northward out of the mine site into Milk Creek and finally into Yampa Valley. The central and eastern portions of the mine site slope downward to the north and east into Streeter Canyon at the north perimeter. Streeter Canyon enters Good Spring Creek Valley just to the northeast of the lease boundary, and Good Spring Creek enters Yampa Valley about 12 kilometers (7.5 miles) to the north.

Rough topography of the mine area causes significant channeling of air masses passing the region. During the evening and early morning hours, air is known to move toward lower elevations. Therefore at the Colowyo Mine, air from the far western portion will flow into Taylor Creek Canyon, but the largest portion of the air mass will move into Streeter Canyon and then up Good Spring Creek Valley toward Yampa Valley. During the afternoon hours when the sun heats the earth's surface, air tends to flow towards higher elevations.

Up-valley flow occurs less frequently in rough terrain than down-valley flow because of its dependence on strong solar heating. For example, on overcast days or during storms, air in the mid-latitudes moves in from the west (prevailing westerlies) rather than following terrain features. Similarly, when the ground is snow-covered, even abundant sunshine will not heat the earth's surface significantly during the afternoon, so up-valley flow is not produced. These restrictions on the frequency of up-valley flow are assumed to apply to the Colowyo Mine site. It is estimated that down-valley flow occurs about 50 percent of the year and up-valley flow about 10-20 percent of the year.

Average hourly wind speed varies with the time of day. Wind speeds reach average maximum values during summer afternoons and are usually associated with up-valley flow. During this time, air is capable of substantial vertical mixing and therefore pollutants are dispersed easily. During the evening and early morning hours, average hourly wind speeds are low. Pollutants are poorly dispersed because there is little vertical mixing. At the Colowyo Mine it is estimated that afternoon wind speed will average five meters per second (mps) (10 mph), and evening wind speed will average two mps (four mph).

Strong wind speeds greater than 10 mps (20 mph) will occur during abrupt weather changes or storms. Wind data collected at Craig weather station for the Yampa Project indicate that strong winds occur about three percent of the time annually, primarily during the winter and spring months. Although the Craig weather station was located nearly 30 kilometers (20 miles) from the Colowyo Mine site, the frequency of strong winds is expected to be similar at both locations.

Observations near the towns of Craig, Hayden, and Steamboat Springs indicate that the region often has no air movement at all. These calm conditions can occur any time of day, but are more frequent during the evening and early morning when air mixing is poor, and therefore potential pollution episodes most likely. Wind speeds of less than one mps (two mph) are expected nearly 20 percent of the time at the Colowyo Mine site.

Measurements of annual precipitation at the mine are unavailable, but historical records from the nearby towns of Meeker and Hamilton indicate that about 46 centimeters (18 inches) can be expected per year. Precipitation is greater during the summer months, averaging about two-thirds of the total amount. The remainder falls in the winter in the form of snow, averaging 178 centimeters (70 inches) per season. It is estimated that 80 days/year precipitation is greater than the detectable limit of .25 millimeters (0.01 inches) at the Colowyo Mine.

Similar to the entire region, the mine area is subject to large seasonal and daily temperature variations. In July, temperatures are expected to vary from 30°C (86°F) during the day to 6.7°C (44°F) at night on the average. January extremes vary from an average of 1.1°C (34°F) during the day to -15°C (5°F) at night. The growing season is assumed to be similar to that recorded at Meeker, or about 90 days.

Air Quality

Ambient concentrations of the nationally regulated air pollutants are difficult to determine at the Colowyo Mine because no monitoring data are available. Therefore baseline concentrations of air pollutants are assumed to be the same as measured in other rural western regions. These concentrations are: total suspended particulates, 20 $\mu g/m^3$; sulfur dioxide, 15 $\mu g/m^3$; nitrogen oxides, 15 $\mu g/m^3$; carbon monoxide, 400 $\mu g/m^3$; non-methane hydrocarbons, 50 $\mu g/m^3$; and ozone, 660 $\mu g/m^3$. A discussion of the measurements from which these backgrounds were determined can be found in the Regional Analysis Air Quality section of this Environmental Impact Statement.

Visibility at the mine is also assumed to be similar to the regional visibility. Maximum visibility on clear days is estimated to be about 100 kilometers (62 miles) but averages about 25 kilometers (15 miles) over the year. Worst case conditions of heavy fog reducing the visibility to less than 300 meters (0.2 miles) are expected to occur only a few days every year.

Living Components

Soils

W. R. Grace coal lease D-034365 is in the northwest corner of Colorado on the north-facing slopes of Danforth Hills. The area is located on the south flank of the Axial Basin uplift, which forms the southern portion of the Wyoming Basin physiographic province. This area is typified by rather high plateaus and mesas, isolated mountain ranges, and steep mountain slopes. The study area is characterized by gently sloping north-facing mesas in a region of rolling hills and narrow valleys. Elevation ranges from 7,000-7,600 feet. General topography varies from steep escarpments and canyon walls to gently sloping mesa tops and alluvial fans. Taylor, Wilson, and Good Springs Creeks are the main drainages; other minor drainage courses and intermittent streams have cut through the study area giving rise to the rolling hill topography.

Soils of the W. R. Grace lease site have been formed by physical and chemical weathering of sedimentary rocks (parent material); most soils in the study area are residual. Rock that underlies the soil at various depths (16-60 inches) is dependent on the intensity and duration of the weathering processes. Parent material and the climatic conditions under which the soils have developed are the dominant forces in determining soil characteristics. The soils have developed in a cool, semiarid climate; parent material consists primarily of sandstone and shales of Williams Fork and Iles Formations of Mesaverde Group.

There are three broad landforms on which the soils have formed that were recognized in the W. R. Grace lease site. These are soils that developed on: (1) narrow to broad, gently sloping to rolling ridgetops, (2) moderately steep to steep side-slopes, and (3) in the nearly level to gently sloping concave narrow stream valleys.

The soils have a wide range in texture, color, and thickness, dependent on landform and aspect. Generally ridgetop soils have surface soils that are dark-colored loam or clay loam, with small areas of sandy loam, fine sandy loam, clay, and silt loam. Organic matter content is moderate. The subsoils are dominated by clay where developing over shale, and by sand developing over sandstone. Textures are dominated by clay but include silty clay, silty clay loam, sandy clay loam, clay loam, loam, and fine sandy loam. Soil depth ranges from 12-48 inches.

Soils on the side-slopes are light-colored both in the surface and subsurface when the aspect is southerly. Dark-colored soils occur on the cooler and more moist northerly aspect. These soils are very shallow (less than 10 inches) and rocky or stony. Organic matter content ranges from low to high.

Soils of the stream bottoms are generally deep (over 60 inches), dark-colored, and loamy in texture. Soil profile has a thin lens of gravelly material and occasional stones. Organic material content is moderate to high.

The location of typical soil profiles (numbers 1 through 9) are shown on the soil map for each major land classification unit mapped at the study site (Figure GII-7); chemical and physical data from each profile are presented in Table GII-6. Because of the limited soil survey work by USDA-SCS in the area, only a generalized attempt was made to establish the taxonomic units for the soils. It was determined that most of the soils are in the order Mollisols and the sub-order Borolls. Soils on steep south slopes are in the order Entisols and in the sub-order Orthents.

Typically, the soils have surface layers that are dark grayish brown to dark brown. Subsurface layers are gray to light grayish brown. They usually contain some iron mottling. The subsoils contain moderate amounts of calcium carbonate in the form of splotches. Organic matter, although not unusually high, has an effect in darkening surface layers. Soils of the stream bottoms are usually higher in organic matter than upland soils and are darker, deeper into the profile. They are a very dark grayish brown when dry, and very dark brown when moist.

Soil textures for the area range from sandy loam to clay. Surface textures are usually loam or clay loam but include sandy loam, clay, and silt loam. Subsoils are usually finer-textured than the surface, and range from clay loam to clay.

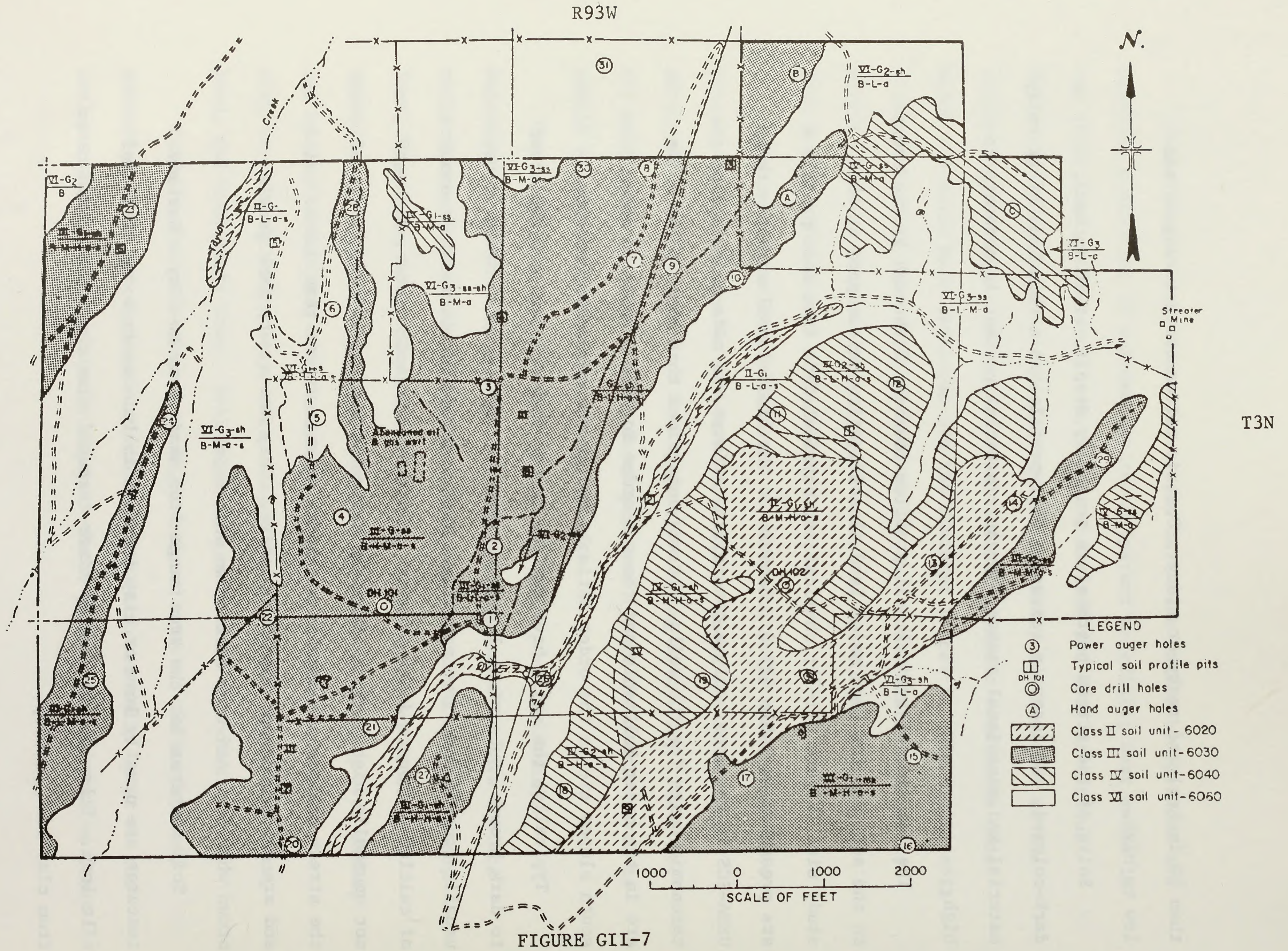


FIGURE GII-7

Soil unit classification map - Taylor Creek site.

TABLE GII-6

Chemical and Physical Data for Soils of the W. R. Grace Colowyo Mine Site, Moffat County, Colorado

Lab.	Hori-	Depth	Tex-	pH	Extract		Saturation Extract (me/l)									Exchange me/100 gm					Percent		
No.	zon	(In.)	ture*	Rate	pH	$EXCIO^3$	CO_3	HCO_3	Cl	SO_4	Ca	Mg	Na	P	SAR	Tot. Na	Sol. Na	ES	ESP	CEC	Sand	Silt	Clay
Typical profile No. 1																							
84	A1	0-3.5	l	6.6	8.1	1	-	7	1	1	5	3	1	1	1	1	-	1	1	27	34	31	24
85	B1	3.5-21	l	6.6	8.5	1	1	5	1	1	3	2	1	1	1	1	-	1	1	27	42	42	16
86	B2t	21-46	cl	6.5	8.4	1	1	3	1	1	2	1	1	-	1	1	-	1	1	26	24	27	37
	R	46-60	weathered shale																				
Typical profile No. 2																							
87	A	0-60	l	6.9	8.4	1	-	3	1	-	2	1	1	1	1	1	1	1	1	25	27	47	26
Typical profile No. 3																							
88	A1	0-12	sl	7.0	8.2	1	-	6	1	96	4	2	1	1	1	1	-	1	2	11	58	25	17
89	B'21t	12-34	c	8.2	8.6	1	1	4	1	2	2	3	2	1	1	1	1	1	2	34	13	29	58
90	B'22	34-48	c	8.1	8.3	5	1	5	1	76	26	47	11	1	2	2	1	1	2	68	14	38	48
91	B'23	48-60	c	8.3	8.4	5	1	5	1	60	12	40	16	1	3	2	1	1	3	33	10	35	55
Typical profile No. 4																							
92	A&B	0-32	c	7.8	8.6	1	1	3	1	1	3	2	1	1	1	1	-	1	1	29	13	41	46
93	B2	32-36	sec	8.1	8.6	1	1	3	1	1	2	1	1	-	1	1	-	1	1	24	12	47	41
94	C	36-48	secl	8.3	8.6	1	1	3	1	1	2	2	1	-	1	1	-	1	1	16	16	54	30
	R	46-60	weathered mudstone																				
Typical profile No. 5																							
95	A1	0-4	l	7.6	8.1	1	-	8	1	1	9	1	1	1	1	1	-	1	2	15	45	34	31
96	C1	4-6	l	7.8	8.1	1	-	5	1	1	6	1	1	1	1	1	-	1	2	14	29	39	42
97	C2	6-16	l	8.0	8.3	1	1	3	1	1	3	1	1	1	1	1	-	1	2	12	26	27	27
	R	16-34	weathered sandstone																				
Typical profile No. 6																							
98	A11	0-2	cl	7.4	8.2	2	-	12	3	4	13	4	1	1	1	1	-	1	1	31	28	33	39
99	A12	2-4	c	7.5	8.2	1	-	9	1	3	10	4	1	1	1	1	-	1	1	31	23	34	43
100	B2t	4-28	c	7.9	8.6	1	1	3	1	1	2	2	1	-	1	1	-	1	2	30	8	36	56
101	B3	28-60	sic	8.4	8.7	1	1	3	1	1	1	2	3	1	2	1	-	1	3	24	7	50	43
	R	60-84	weathered shale																				

TABLE GII-6 (cont'd)

Chemical and Physical Data for Soils of the W. R. Grace Colowyo Mine Site, Moffat County, Colorado

Lab. No.	Horizon	Depth (In.)	Texture*	pH Rate	Extract		Saturation Extract (me/l)									Exchange me/100 gm					Percent		
					pH	EXClO^3	CO$_3$	HCO$_3$	Cl	SO$_4$	Ca	Mg	Na	P	SAR	Tot. Na	Sol. Na	ES	ESP	CEC	Sand	Silt	Clay
Typical profile No. 7																							
102	A11	0-2	cl	7.6	8.2	1	-	12	1	2	12	2	1	1	1	1	1	1	2	24	35	28	37
103	A12	2-11	c	7.4	8.1	1	-	6	1	2	5	2	1	1	1	1	1	1	1	27	27	31	41
104	B2t	11-23	c	7.7	8.2	1	-	3	1	1	2	1	1	1	1	1	1	1	2	29	8	35	57
105	B3	23-29	c	7.9	8.4	1	1	3	1	1	3	2	1	1	1	1	1	1	2	21	10	41	27
106	C	29-36	l	8.3	8.5	1	1	3	1	1	2	3	1	1	1	1	1	1	3	15	26	47	27
	R	36	fractured sandstone																				
Typical profile No. 8																							
107	A1	0-5	l	6.8	8.2	1	-	9	1	2	4	5	1	1	1	1	1	1	2	21	39	36	25
108	B21t	5-16	c	7.2	8.7	1	2	6	1	2	2	5	5	1	2	1	1	1	2	35	21	24	35
109	B22t	16-22	c	8.1	8.6	3	1	4	1	31	5	13	19	1	6	4	2	3	7	38	12	29	59
110	C	22-37	c	8.1	8.3	10	-	4	8	144	24	75	56	1	9	7	4	3	6	.52	13	40	47
	R	37-60	weathered shale																				
Typical profile No. 9																							
111	A1	0-2.5	sil	7.0	8.0	1	0	6	1	4	6	2	1	1	1	1	-	1	1	27	21	54	25
112	B1	2.5-10	sicl	6.8	8.2	1	-	8	1	2	7	3	1	1	1	1	-	1	1	27	18	47	35
113	B2t	10-22	c	7.3	8.6	1	1	4	1	1	2	2	1	1	1	1	1	1	1	45	14	34	51
114	B31	22-40	c	7.9	8.2	1	-	3	1	1	2	1	1	-	1	1	-	1	1	35	6	37	57
115	B32	40-48	sic	8.1	8.2	1	-	3	-	1	1	2	1	-	1	1	-	1	2	28	8	48	44
	R	48-60	weathered shale																				

*c, clay; cl, clay loam; l, loam; sl, sandy loam; sic, silty clay; sicl, silty clay loam; sil, silt loam.
Chemical and Physical data is rounded off to nearest whole number. Data indicated by number 1 generally has a value of less than 1.

The Unified System classified surface soils as silts (ML), lean clays (CL), and silty sands (SM). The subsoils are basically lean clays (CL), sticky and medium plastic when wet and medium hard when dry.

The shales weather into fat clays (CH) that are highly plastic, tough, and very hard when dry. The subsoils have a very slow permeability and a low stability when water saturated.

The soils vary in depth from very shallow (less than 6 inches) on the side-slopes, to very deep (more than 60 inches) in the stream bottoms; average depth along the ridgetops is 12-48 inches.

Some surface soils are structureless where there is no observable, definite, or orderly arrangement of soil aggregates. Other surface soils have a weak, fine, and platy structure or a moderate and very fine to fine and granular structure. Subsoils usually consist of angular blocky to very strong medium to very coarse prismatic structure.

The dry consistency of these soils is characterized by surface layers that are slightly hard, and subsoils that are very hard to extremely hard. The moist consistency is usually friable to firm. The wet consistency is slightly sticky and slightly plastic to very sticky and very plastic.

There is little evidence of cementation even though there were zones of calcium carbonate accumulations throughout the subsoil and near the contact zone of the underlying parent material. The parent material, especially the sandstone and shales when exposed to weathering, are moderately to weakly cemented.

Permeability of most of the soils is slow to moderately slow. This rating is based on soil textures and other observable characteristics in the subsoil or equivalent layers. Soils at the site have a moderate-high water holding capacity. Surface layers (sandy loams to clay loams) would be somewhat less than the clays of the subsoil or equivalent layers.

Surface soils moisture retention measured at 15-Bar tension varied from 10.4 and 21.0 percent; subsoils were somwhat higher ranging from 13.8 and 21.9 percent.

The soils show a wide range in the cation exchange capacity (CEC) due to the amount of clay and organic matter present in the parent material (Table GII-6). Soils developed over shales show the highest CEC; alluvium mudstone and sandstone show lesser capacities in a descending order.

Residual soils on shale have A1 horizons that have a CEC range from 11-31 millequivalents/100 grams and range in texture from sandy loam to clay. Subsoil (B2 horizons) ranges from 24-68 me/100 gms; textures range from loam to clay. The high CEC values can be attributed to montmorillonitic clays. Soils developing in alluvium are loam texture and have 25 me/100 gms. Residual soils on mudstone have A1 horizons of clay and 29 me/100 gms. Subsoils (B2 horizons) are clay with 24 me/100 gms and substratum (C horizon) of clay with 16 me/100 gms. The lower CEC values could be attributed to the high sand content. Residual soils on sandstones have A1 horizons of loam, clay loam, and clay with 15 to 29 me/100 gms. The substratum (C horizon) is in loam or clay with 12 to 15 me/100 gms. The overall low values could be attributed to the higher sand content.

Soils in the W. R. Grace lease are naturally calcareous. They have developed zones of lime accumulations but do not have a definite calcic horizon. Calcium carbonate veins are present in lower parts of most soil profiles. The reaction to dilute hydrochloric (HCL) acid ranged from slight to violent; reaction usually became greater with depth. The parent material, particularly the sandstones, reacted with the dilute HCL acid. It was noted that the soils reacted differently depending upon position, depth, and type of parent material.

Mottling was noted in most soils of the area, usually as iron (Fe) stains predominantly below the 12-18 inch layer. Soils in this area are usually nonsaline to only slightly saline. There was little evidence of any acid soils.

The pH values at 25°C on a 1:5 dilution ranged from 7.0-8.8. Electrical conductivity indicated most soils were only slightly saline with most readings generally below one milli-mohs/centimeter.

Internal drainage of soils at the site appears to be medium to slow. Saturation occurs for short periods early in the spring. In a few isolated locations, saturation occurs for longer periods lasting well into summer or early fall. On the average, internal drainage was not as free as in a rapid state but more free than in a slow state, and was limited to periods of a week or less. In no instances was it noted to affect plant growth or root development.

There are areas of stoniness along the ridgetops and most side-slopes are very stony. Stoniness varies with slope; the steeper the slope, the more stony or rocky the surface.

There were no deposits of gravel of any significance found in the study area. Near the Streeter mine there were deposits of scoria that were being used as road material but were of poor quality. Typical soil 8 shows a moderate salinity problem in the subsoil, Table GII-6.

Depth to weathered material varied with location and parent material. Mudstones seemed to be more resistant than the shales and sandstones. Drilling with a truck mounted power auger accomplished depths of 15-20 feet in the weathered or decomposed geologic material. These depths are not usual; the average normal depth is about 5-10 feet.

Soil inventory

A detailed land unit capability map was prepared by the Bureau of Reclamation. The inventory includes only those portions of the mine plan that lie in Sections 2, 3, and the N 1/2 of Section 10, T.3N., R.93W. This land unit capability map was made to determine location, extent, and quality of surface soils, and to characterize overburden materials as to reclamation potential. Surface soils were delineated into units based on potential for topsoil and its distinguishing characteristics.

During the study, four major land unit capability classes were identified, described, delineated, and indicated by the use of Roman Numerals II, III, IV and VI (Figure GII-7).

Surface soils are also designated into a soil map symbol or number as established by the BLM for the State of Colorado. The major soil units were assigned the numbers 6020, 6030, 6040, and 6060 with variations within these major units being numbered consecutively as 6021 or 6022 etc, for each of the major variations within the mapping units (Figure GII-7).

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The area in the mine plan that lies outside of lease D-034365 consists of soils within Soil Association 59 (see Regional Analysis, Chapter IV).

Description of mapping units

Land unit capability II

The majority of soils in this unit have developed from residual material. Typical soil profiles describing the important soil characteristics are listed hereafter and also in Table GII-6.

Mapping Unit 6020 consists principally of the deep (over 60 inches) valley-filling loamy materials in the narrow stream bottoms of the area. They consist of dark-colored alluvium with a dominant loam to clay texture. They are somewhat stratified with small layers of coarse material consisting of water-worn sandstone rock fragment or gravel-moving watertable at 23 feet. Topsoil potential is more than 60 inches thick and is rated good. Mapping unit 6021 is 36-60 inches deep. It is slightly calcareous with a strong to moderate structural development. It is saline and has a loam surface layer and a clay subsoil.

Topography for much of this land unit is rolling ridgetop with slopes of 5-15 percent. Aspect or exposure is usually north-northeast along the ridges sloping from the high hills to the south. The topsoil is about 10 inches thick and is rated fair to good. Subsoil is too clayey. Vegetation is predominantly sagebrush (*Artemsia tridentata*) with an understory of native grasses and forbs.

Land unit capability III

Mapping units in the series 6030 are shallow to moderately deep (12-36 inches), slight to medium calcareous, and in some cases have strong structure development. Slopes average 5-15 percent, but range from 0-35 percent. They are confined mostly to hill ridge-tops and western exposed side-slopes. Surface textures are usually loams and the subsoil includes clay loam and clay; they are nonsaline.

Soils that have developed under scrub oak (*Quercus gambelii*) on west faces have textures that include loam and sandy loam. These surface soils are trapped wind deposits from higher ridgetops.

Vegetative cover on the northwest-facing slopes is predominantly mountain shrub vegetative type with stands of quaking aspen (*Populus tremuloides*) at the head of draws in small moist depressions. Usually there is a good understory of native grasses in these heavy brush areas.

The ridgetops on the northeast-facing slopes are predominantly big sagebrush, a few sparsely scattered clumps of serviceberry, (*Amelanchier utahensis*), and a fairly good understory of native grasses.

Topsoil potential is about 12-36 inches thick and is rated good. There may be some areas that are saline and very shallow.

Land unit capability IV

Mapping units in the series 6040 are very shallow (less than 12 inches). In most instances, the soil is slightly calcareous. Soil structure is weak or subangular, blocky, and nonsaline. Surface textures are loam and clay loam, and the subsurface is clay or weathered shales and sandstone. Slopes are from 15-30 percent and usually have a considerable amount of surface rock exposed. Surface rock fragments are weathered sandstone and shales. In this unit some of the soils are colluvial.

Vegetative cover on this unit is predominantly big sagebrush which shows signs of poor growth because of soil conditions. There are also sparsely scattered clumps of Utah serviceberry and Utah juniper (Juniperus osteosperma), with some stands of native grasses as understory.

Topsoil potential is poor due to very shallow depth, coarse fragments, excess slope, and rock outcrops.

Land unit capability VI

Maping units in the series 6060 are mostly eroded, exposing bedrock as ledges and cliffs of sandstone, mudstone, or shale; slopes exceed 60 percent.

Surface texture of these very shallow soils ranges from sandy loam to clay loam and is nonsaline. Soil development is weak, and with shallow soils and steep slopes it is susceptible to wind and water erosion.

Vegetative cover for this unit is sparsely scattered juniper, with scattered native grasses growing in and out of rock crevices. Where bedrock is exposed there is no vegetative cover. Topsoil potential is poor due to excess slope, lack of soil material, coarse fragments, and excess rock outcrop.

Terrestrial Flora

Three primary and two secondary vegetative communities exist within the lease boundary of the Colowyo mine. Primary types are sagebrush, mountain shrub, and pinyon-juniper, with the secondary types consisting of aspen woodlands and river bottom. A more detailed description of vegetation and ecological requirements of these vegetative types is found in Chapter IV of the Regional Analysis section of this statement. The approximate extent of the five vegetative types is shown on Figure GII-8. Type designations and numbers are those used by the BLM.

Sagebrush, type 4

The sagebrush communities are characterized by almost complete dominance of big sagebrush (Artemesia tridentata). The growth form of this community is characterized by scattered shrubs of medium height, rarely exceeding four feet. Numerous areas of bare ground exist with various grasses and forbs comprising the understory. The most abundant grass is western wheatgrass (Agropyron smithii), and the most common forb is lupine (Lupinus spp.). On every location in the area where soil moisture retention becomes limiting to the other landscape components, this sagebrush community develops. In this type snowberry (Symphoricarpos oreophilus) occurs locally within the sage where exposure or moisture retention is favorable.

Mountain shrub, type 5

Areas of mountain shrub community are dominated by varying densities of Gambel's oak (Quercus gambelii) and serviceberry (Amelanchier alnifolia). The shrubs of this community range in height from three-twelve feet. Typically oaks grow in large clumps with zones of sagebrush or grasses existing between the denser oak and serviceberry stands. Within this community snowberry is the most common associated shrub.

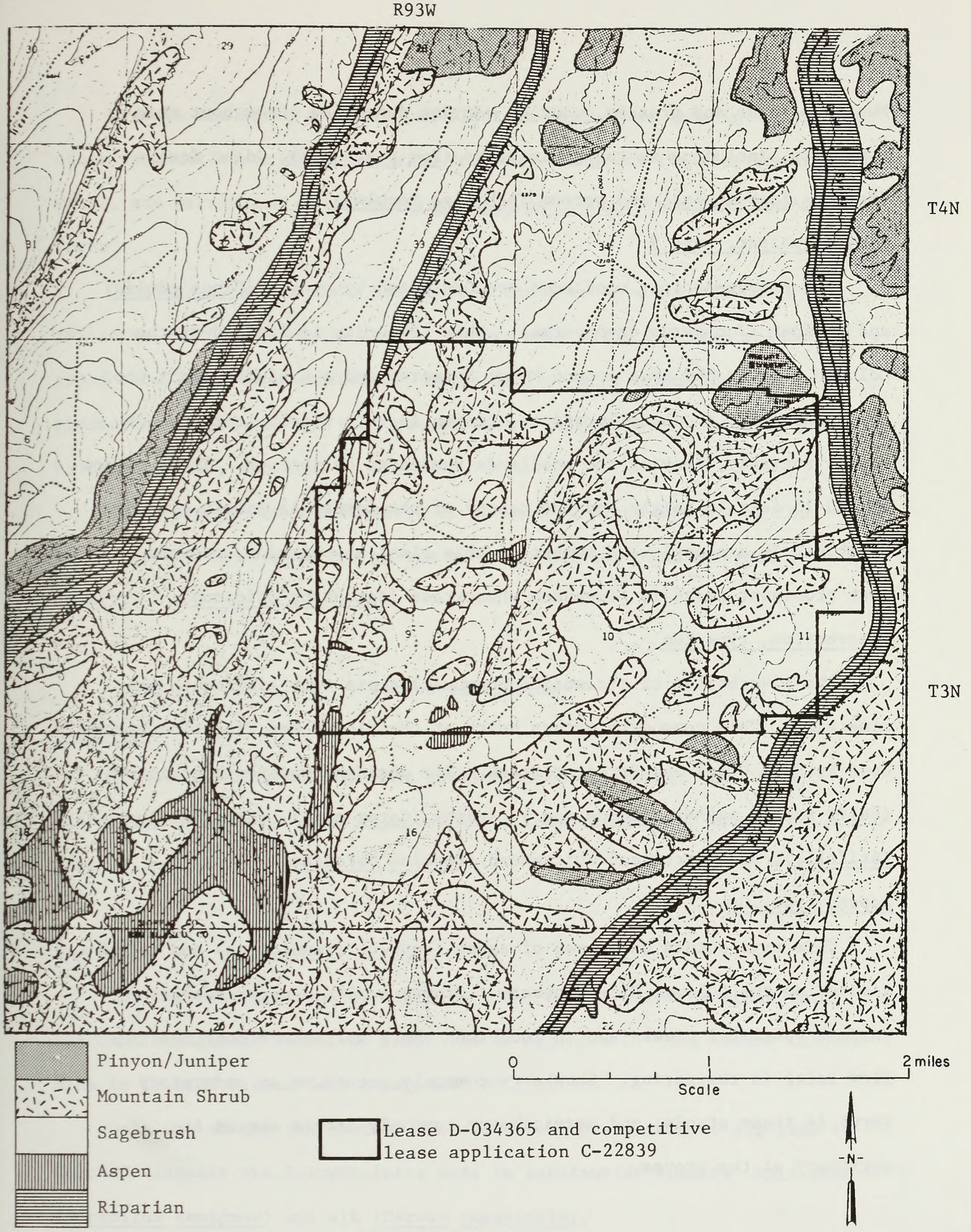


FIGURE GII-8

Vegetative map of W.R. Grace Colowyo mine area.

Numerous forbs and grasses occur in varying densities throughout this community, including Kentucky bluegrass (*Poa pratensis*), Idaho fescue (*Festuca idahoensis*), and yarrow (*Achillea lanulosa*).

Pinyon-juniper, type 9

The pinyon-juniper woodlands are dominated by pinyon (*Pinus edulis*) and juniper (*Juniperus oteosperma*). This community is limited at the Colowyo site to the area around Mount Streeter and the bluffs along Good Springs Creek. In these locations, pinyon is very widely scattered or absent entirely, leaving the woodlands dominated by juniper. Trees seldom exceed 15 feet in height and the canopy of the forest is rarely closed. Sagebrush is a conspicuous member of this plant association, and the most prominent grass is bluebunch wheatgrass (*Agrophron spicatum*).

Riverbottom, type 20a

The riverbottom or streamside communities are very limited on the mine site. This community occurs north of the closed Red Wing mine along Good Springs Creek and Streeter Creek. The dominant species are willows (*Salix* spp.), rushes (*Juncus* spp.), sedges (*Carex* spp.), cattails (*Typha latifolia*), and narrowleaf cottonwood (*Populus detoides*).

Aspen, type 10a

This type occurs as groves of aspen (*Populus tremuloides*) and is very limited on the Colowyo Mine property. Groves occur in upper reaches of various ephemeral creeks and in locations where meltwaters continue to flow later in the spring. Snowberry commonly occurs as an understory shrub in these stands, and serviceberry commonly occurs around the periphery of the groves.

Grasses and forbs are more prevalent in aspen type than in any of the other communities on the site, with Kentucky bluegrass the most dominant grass, and yarrow and dandelion (Taraxacum officinale) the most dominant forbs.

Grazing appears to have had and continues to have a profound influence on the ecosystems at the Colowyo mine site; all five vegetation types show signs of overgrazing. These include soil trampling, low production of grasses and vast quantities of droppings; the area is grazed by cattle, deer, and elk.

There are no known endangered or threatened plant species on the site; however the vegetation on the property has not been analyzed in detail.

Terrestrial Fauna

Wild fauna

A table listing all wildlife species known to inhabit the Colowyo Mine site, as well as those expected to be found within the area, is located in Appendix D.

Big game

The Colorado Division of Wildlife (DOW) has divided the state into 126 Game Management Units, as indicated in Appendix D. The entire Colowyo Mine is located within Game Management Unit 11.

Only two of the ten species that have been designated as big game in Colorado inhabit the Colowyo lease area in substantial numbers: mule deer (Odocoilus hemionus) and elk (Cervus canadensis).

Cougar (*Felis concolor*) and black bear (*Ursus americanus*) are also believed to occur within the proposed mine boundary but only as wandering individuals. No resident animals are known, or expected to be found at this site.

Mule deer. This species inhabits the mine site year-round (see Figure GII-9); greatest population densities appear to be found in the fall, spring, and summer. This indicates that the site provides intermediate and summer deer habitat.

Population estimates on the mine site average about 150 widely scattered mule deer during spring and fall. Summer estimates average 100 head with winter numbers down to approximately 50 animals. Apparently most of the mule deer move off the mine site east along Highway 13, and west along Wilson Creek during the winter.

The overall deer population within the area of influence indicated on Figure GII-9 averages about 600 head in winter and approximately 250-300 animals during the rest of the year. As indicated by the spring and summer population estimates, some deer fawning takes place on the mine property.

Deer numbers within the lease boundary fluctuate depending on several factors including browse condition and climate. Browse plants were in good condition in the summer of 1975 but many plants showed signs of past heavy use (see Appendix D). Some browse plants known to be important as mule deer food that are found on Colowyo Mine site are serviceberry (*Amelanchier utahensis*), Gambel's oak (*Quercus gambelii*), snowberry (*Symphoricarpos utahensis*), big sage (*Artemesia tridentata*), and bitterbush (*Purshia tridentata*).

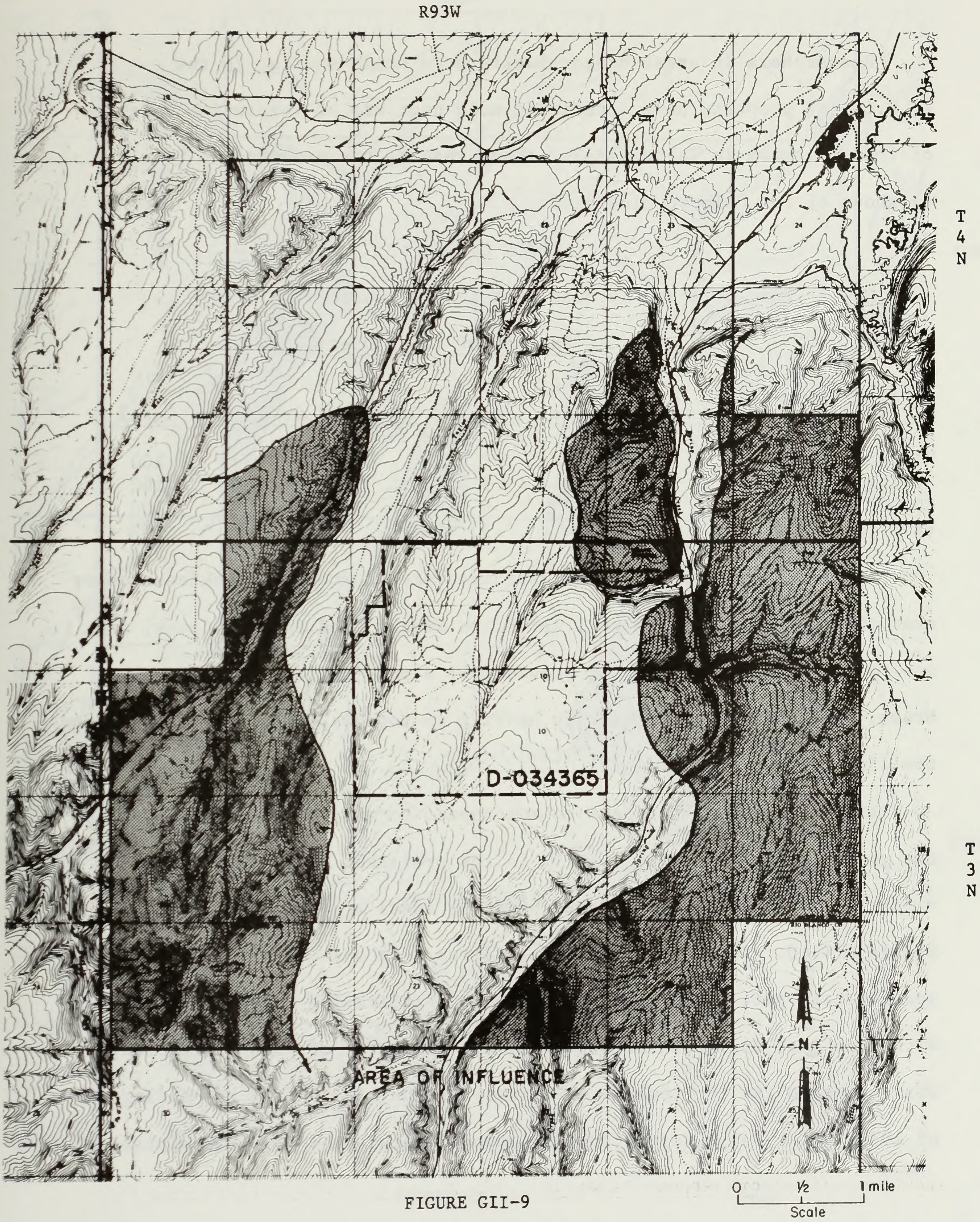


FIGURE GII-9

W.R. Grace Colowyo mine area and winter habitat preferred by mule deer (shaded area).

Researchers in areas of northwestern Colorado similar to the W. R. Grace property have identified mule deer use of vegetation by class of food as shown in Table GII-7. These results are expected to be close to those of the Colowyo Mine site.

TABLE GII-7

Food Utilized by Mule Deer in Northwestern Colorado

Season of use	Shrubs and Trees	Forbs	Grass and Grasslike	Total
	Percent of Total Diet			
Winter	97	2	1	100
Spring	79	9	12	100
Summer	94	6	0	100
Fall	97	3	0	100

Water requirements for mule deer are met by numerous stocktanks on or near the mine property, as well as Wilson Creek, Good Springs Creek, and snow when available. Cover is provided by a combination of topography, brush, and trees. Mule deer rely heavily on topography for protection from the wind.

Elk. Overall elk numbers do not appear to vary significantly during the year although there is a shift in the preferred use areas during various seasons. Elk winter concentration areas are shown in Figure GII-10. Several cow elk with calves have been seen in the southwestern part of Colowyo mine property, indicating a calving area within or just south of the site. An elk calf crop of about 18 percent was estimated for the immediate vicinity of the mine during the spring of 1975 (VTN 1975). Population estimates indicate about 50 elk wintering

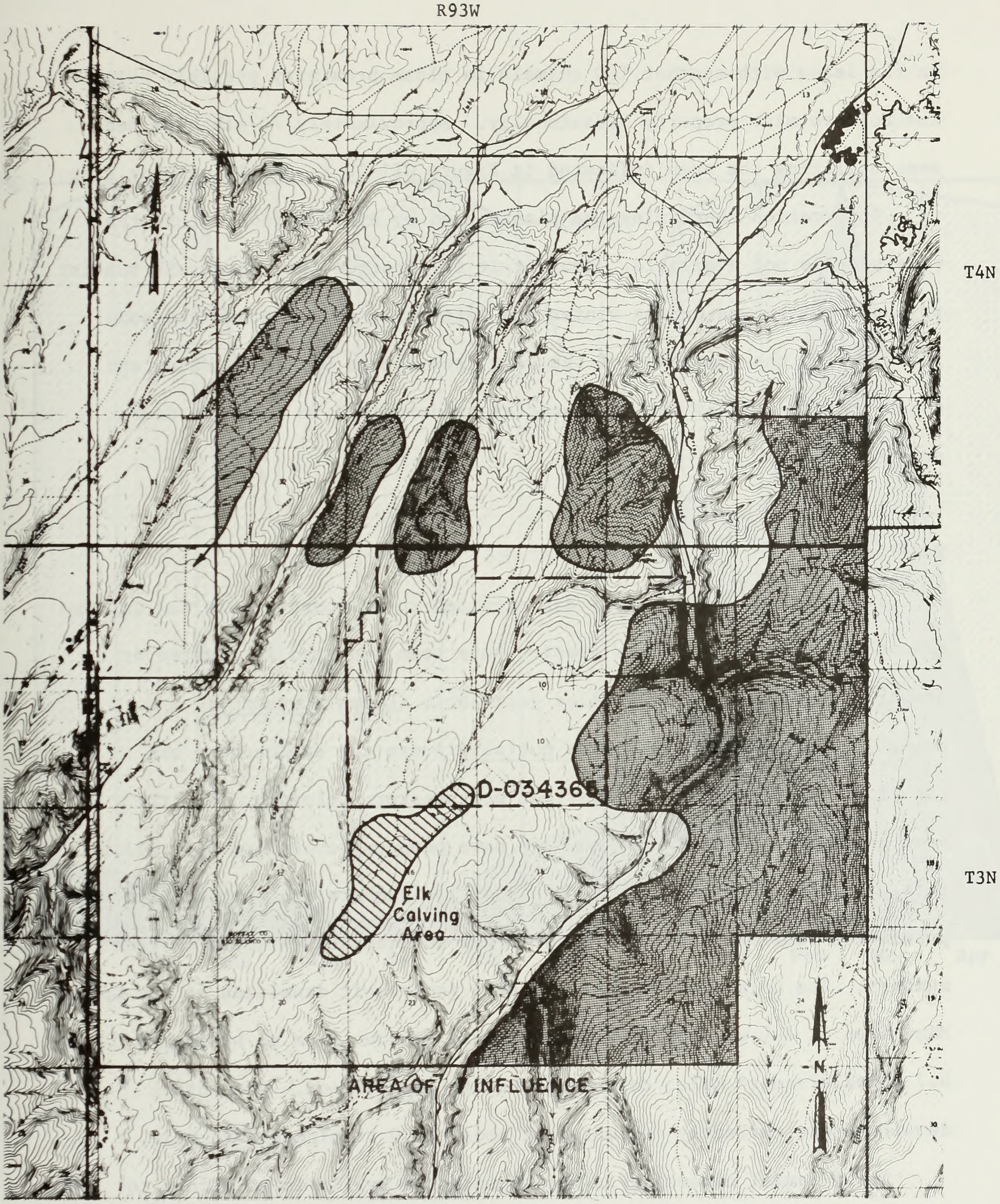


FIGURE GII-10

W.R. Grace Colowyo mine area and winter habitat preferred by elk (shaded area).

on the lease with another 100 animals in close proximity possibly using the Colowyo mine property occasionally. Approximately 70 elk have been seen utilizing the area indicated in Figure GII-10 as an elk calving site.

Information concerning the plants used by elk for food within the mine site is not available. However it is expected that these elk subsist primarily on browse during winter and late fall, and on grass and some forbs during the remainder of the year (see Figure GII-11). Water and cover are provided by the same sources as described in the mule deer section.

Small mammals

Two species of lagamorphs are expected to be found within the Colowyo Mine boundary although other species have been reported as sighted or probably occurring. White-tailed jackrabbit (Lepus townsendii) and Nuttall's cottontail (Sylvilagus nuttallii) are the common hare and rabbit species found in this part of northwestern Colorado. For the past several years lagamorph numbers have been extremely low over all of this part of the state; because of these low numbers and similar periodic population fluctuations it is hard to get an accurate estimate of their numbers. The Colorado DOW has estimated jackrabbit densities at the Colowyo Mine area at 4.0 animals/square mile; this is down from an estimated 9.7 animals/square mile, calculated before the decline. Cottontail densities are currently estimated at about 10.0 rabbits/square mile.

Small mammal censusing is being conducted by VTN in an effort to determine probable species diversification and relative population

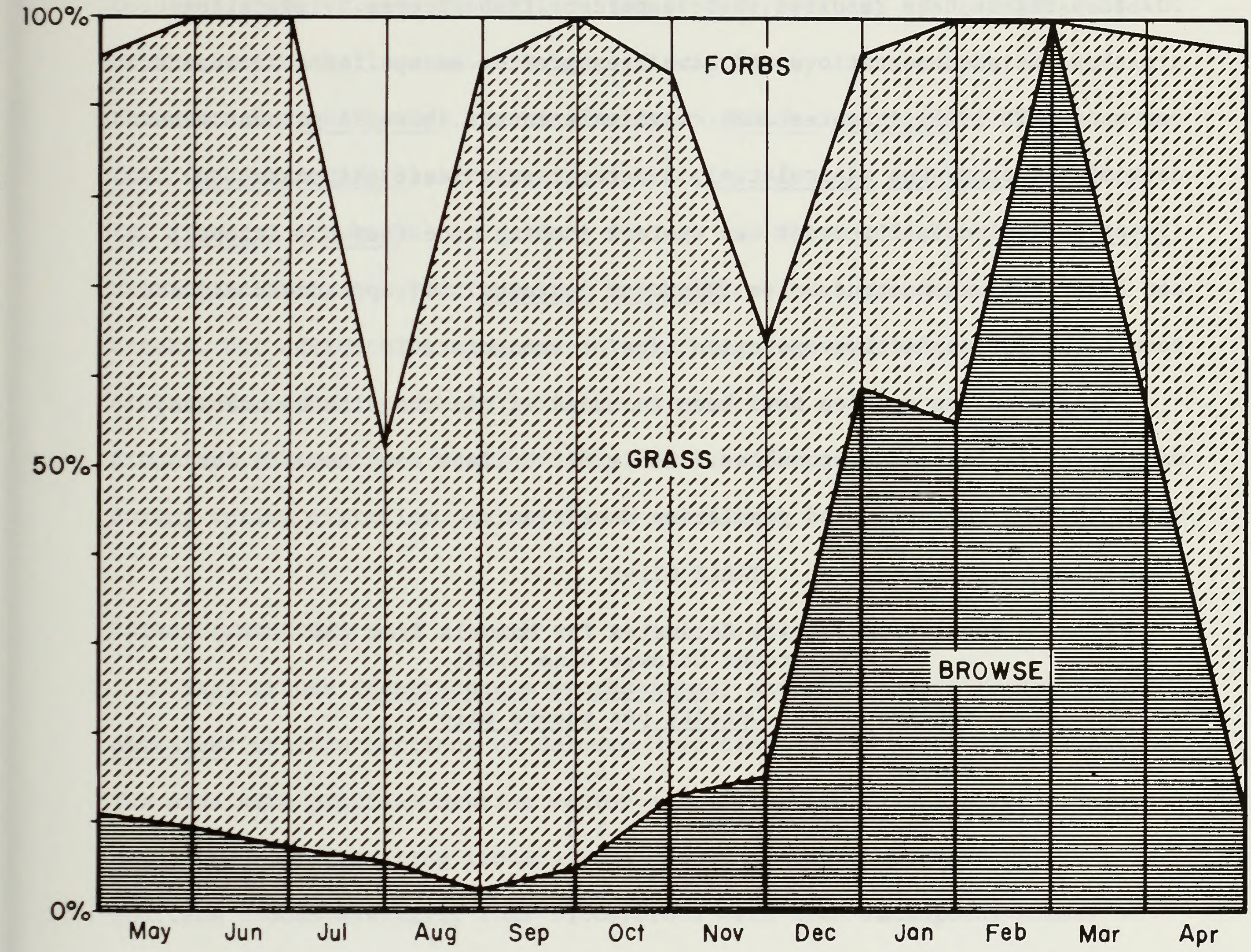


FIGURE GII-11

Probable food classes utilized by elk in the Colowyo mine area.

densities. These studies are continuing; present data are not sufficient to determine these population parameters. However, up to the present time 552 trap nights have resulted in a 54 percent trap success. Indications are that the success ratio would have been greater except for cold weather and snow (VTN 1975). A breakdown of animals caught shows 96 percent were deer mice (*Peromyscus maniculatus*); 2 percent were least chipmunks (*Eutamias* minimus); 1 percent was western jumping mice (*Lapus* princeps); and 1 percent was montane voles (*Microtus montanus*). Trap success did not seem to be influenced by vegetation type or exposure (VTN 1975).

Many wildlife species have been recorded within the site boundaries; many more are listed as probables. Table GII-8 lists some mammals for which the DOW has estimated population densities.

TABLE GII-8

Population Density Estimates for Mammals from the Area around Colowyo Mine (DOW)

Species	Density per square mile
Beaver	6.1
Weasel	0.5
Striped skunk	2.0
Coyote	0.1
Bobcat	0.3
Red fox	0.1

Beaver (*Castor canadensis*) are found along Wilson and Taylor Creeks; however none are present in the area proposed for mining. The other species listed in Table GII-8 are probably found within the site boundary, but (as indicated) all population densities are relatively low.

Waterfowl

Many species of waterfowl are known to migrate through this part of Colorado; however only the mallard (Anas platyrhynchos) has been observed on the stocktanks located on Colowyo Mine property. Other species such as the pintail (Anas acuta), American widgeon (Mareca americana), cinnamon teal (Anas cyanoptera), green-winged teal (A. crecca), and blue-winged teal (A. discors) are known to use Good Springs and Wilson Creeks. Some nesting activity has been observed by the three teal species along these creeks, but adequate nesting cover is lacking from most of the Colowyo stocktanks, reducing the probability of waterfowl nesting on the mine property. The subject area probably receives its greatest waterfowl use during spring migration, mainly March and April.

Upland gamebirds

Sage grouse (Centrocercus urophasianus) and blue grouse (Dendragapus obscurus) utilize portions of Colowyo Mine site during parts of the year. The mine site provides nesting and brood rearing habitat for sage grouse even though no strutting grounds have been found on the property. Fourteen broods averaging four birds/brood were seen during the summer of 1975. Two broods of blue grouse (about ten birds) were recorded during this same time.

Mourning dove (Zenaida macroura) also inhabit the subject area during the spring and summer months. Mourning dove numbers on the mine site are reported as low; however greater densities have been recorded to the north in Axial Basin.

Hawks, eagles and falcons

A great variety of raptorial birds have been seen within the Colowyo Mine boundary, as indicated in Appendix D.

The American kestrel (Falco sparverius), marsh hawk (Circus cyaneus), and red-tailed hawk (Buteo jamaicensis) are the most commonly seen birds of prey in the area. No raptor nest sites have been identified within the lease area at this time.

A peregrine falcon (Falco peregrinus) has been sighted in almost the same location in the past two summers (see Figure GII-12), on the north edge of the proposed mined area (VTN 1975). This falcon probably uses the mine site as a hunting range; the duration of this use is unknown.

Other birds

A variety of non-game birds have been recorded within the lease area and many more are listed as probables. A table in Appendix D ties the use areas the birds prefer to vegetative types.

A bird transect has been established in Section 4 of R.93W., T.3N., by the U.S. Fish and Wildlife Service. It will be used to monitor the avifuna's response to habitat disturbance caused by the proposed mine operation.

Amphibians and reptiles

Few species of this group have been identified as occurring within the proposed mine boundary. No specific information is available in regards to habitat values for these animals; however, based on habitat

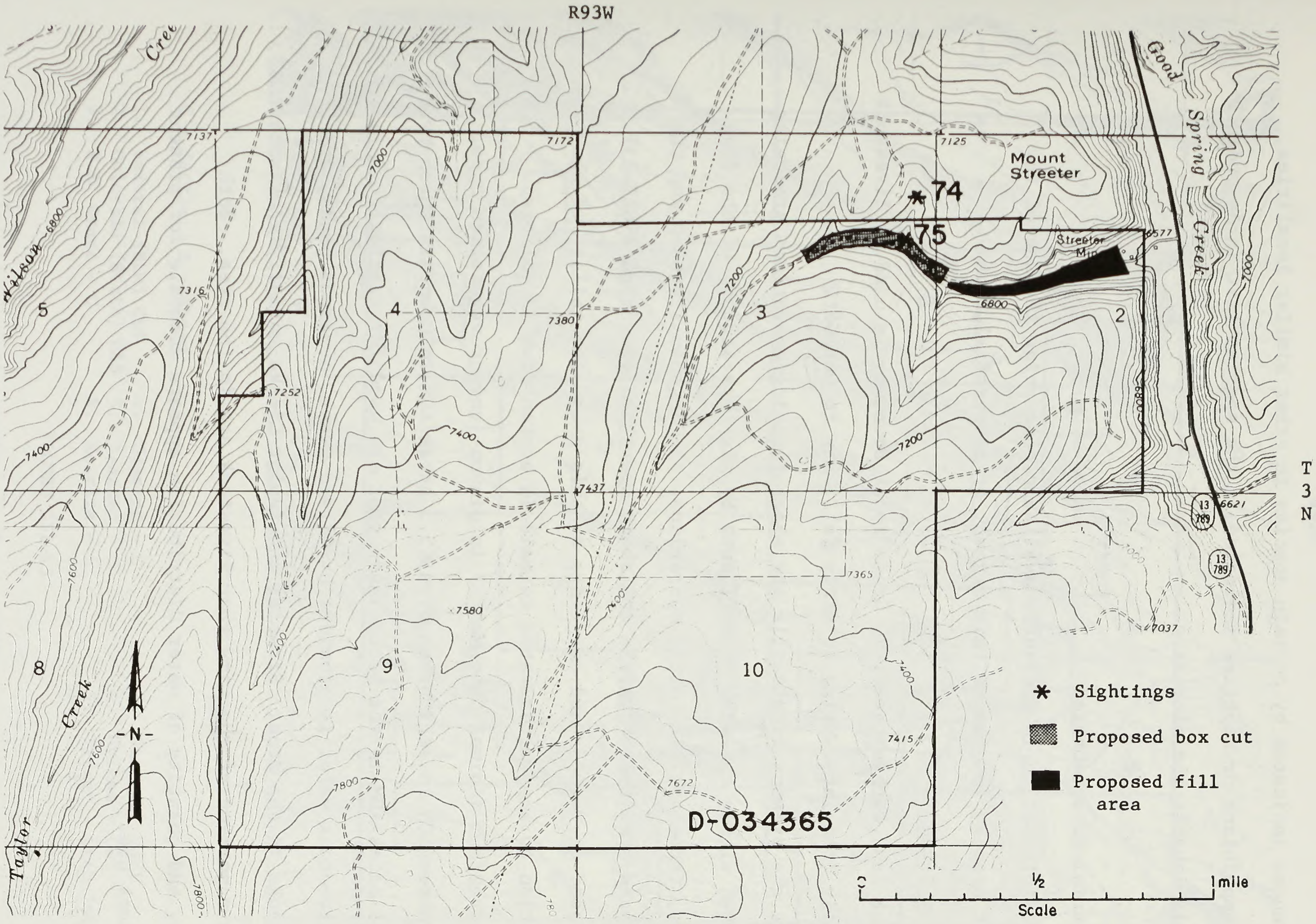


FIGURE GII-12

Peregrine falcon sightings in Streeter Canyon.

preferences indicated by certain species in other similar localities, those amphibians or reptiles indicated in the species list in Appendix D possibly inhabit the mine site.

Terrestrial invertebrates

No information is currently available concerning the use of the subject area by species of this segment of terrestrial fauna.

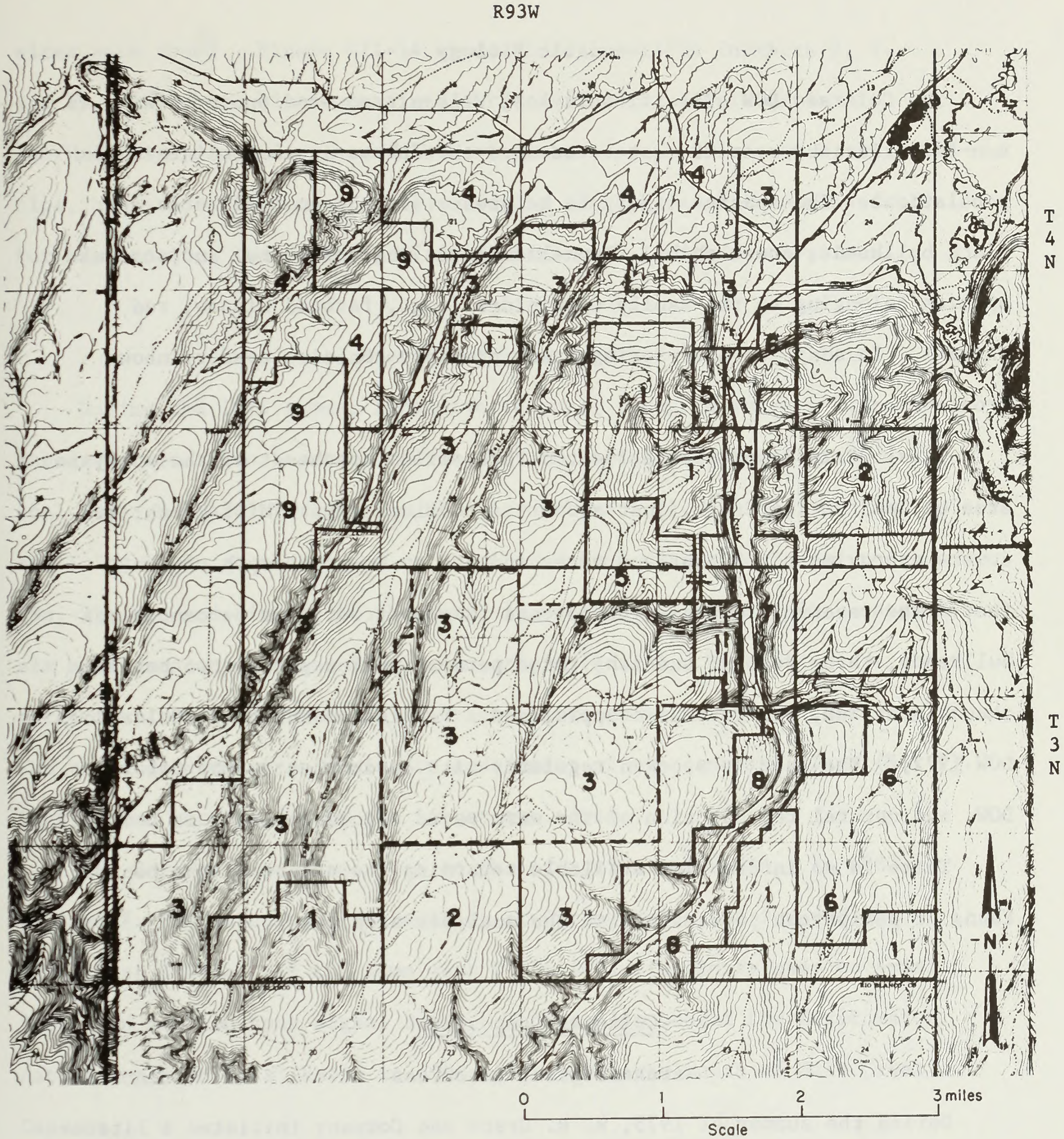
Domestic fauna

The land within the W. R. Grace lease boundary is used by livestock primarily from late spring to early fall, May to October.

At the present time cattle and sheep ranching operations are being conducted within the area of influence by five operators. Of the five ranches, three are all cattle operations, one is totally sheep and the other is a combination cattle and sheep operation (see Figure GII-13).

Based on records and knowledge of this area, the ability of the vegetation to support domestic animals is broken down as follows: 27.5 acres/AUM (Animal Unit Month) in pinyon-juniper vegetation type, seven acres/AUM in sage brush type, 5.5 acres/AUM in mountain shrub type, and 3.5 acres/AUM in the bottomlands that are used for grazing.

Livestock water is provided by Wilson Creek, numerous ponds, and stocktanks in the area. Streeter and Taylor Creeks normally flow water during a portion of the time that livestock are in the area. Both quality and quantity of water distribution appears adequate for present livestock use.



C - Cattle S - Sheep

1. Federal (BLM) C&S
2. Colorado (State) C&S
3. W.R. Grace - C
4. Gossard - C
5. Leander - C
6. Kourlis - S
7. Streeter Coal
8. Durham - C&S
9. Fitzer - Utah Int.

FIGURE GII-13

Landownership as of June 1975.

Aquatic Biology

The Colorado DOW classifies Taylor, Wilson, and Good Spring Creeks as non-fisheries; however it must be assumed that these streams maintain fish populations. The species likely to be present in the analysis area are black bullheads, creek chubs, flannelmouth and white suckers, and several species belonging to the family Cyprinidae (e.g., fathead minnow, red shiner). In addition Good Spring Creek probably contains some rainbow trout.

Axial Basin Reservoir is located three miles northeast of the analysis area on Good Spring Creek, just above its confluence with Milk Creek; it covers approximately 20 surface acres and has an average depth of ten feet. The reservoir contains 80 percent rainbow trout, ten percent black bullheads, three percent sunfish, three percent yellow perch, two percent channel catfish, two percent crappie, and a few largemouth bass (Colorado DOW 1972). The lake is stocked regularly with catchables by the Colorado DOW, and natural reproduction of the warm water species present is common.

There is no information available regarding the nature of the benthic fauna or periphyton populations in the analysis area.

Cultural Components

Archeological Resources

During the summer of 1975, W. R. Grace and Company initiated a literature search and an intensive cultural resource survey of the proposed mine area. Under the direction of Dr. Joe Lischka, Colorado University, three sites were found. Figure GII-14 shows their locations (numbers 2, 3, and 5). All three sites contained surface finds of lithic materials (worked stone) including several chert flakes, projectile points, knife tips, and a sandstone mano. The surveying archaeologist recommended further testing, i.e. digging of small pits with limited excavation.

Historical Resources

During the 1975 summer intensive cultural resource survey, historical resources were also located. Three historic sites were found on Federal coal lease D-034365 (see Figure GII-14, numbers 1, 4, and 5). One is a small log house at the bottom of Streeter Canyon with a collapsed roof (No. 1); age and history of the house is unknown. A second site contains six small sandstone piles of unknown origin (No. 4). Five piles are about three feet thick and twice as long; the sixth is about thirty feet long. The third site merely contains an assortment of tin cans and glass (No. 5). Testing was recommended on the latter two sites.

The Colowyo Mine lease lies on the edge of Axial Basin. In 1882 William S. Taylor engaged in ranching at Spring Gulch and founded the Axial Post Office. In the same year C. J. (Charlie) Duffy came to Axial Basin and settled near Signal Butte. Thomas Iles bought the first major cattle ranch in Axial Basin in 1904, located at the mouth of Milk Creek Canyon.

Aesthetics

Visibility of mining operations at the Colowyo Mine is determined by public access routes -- in this area, both county and State highway systems.

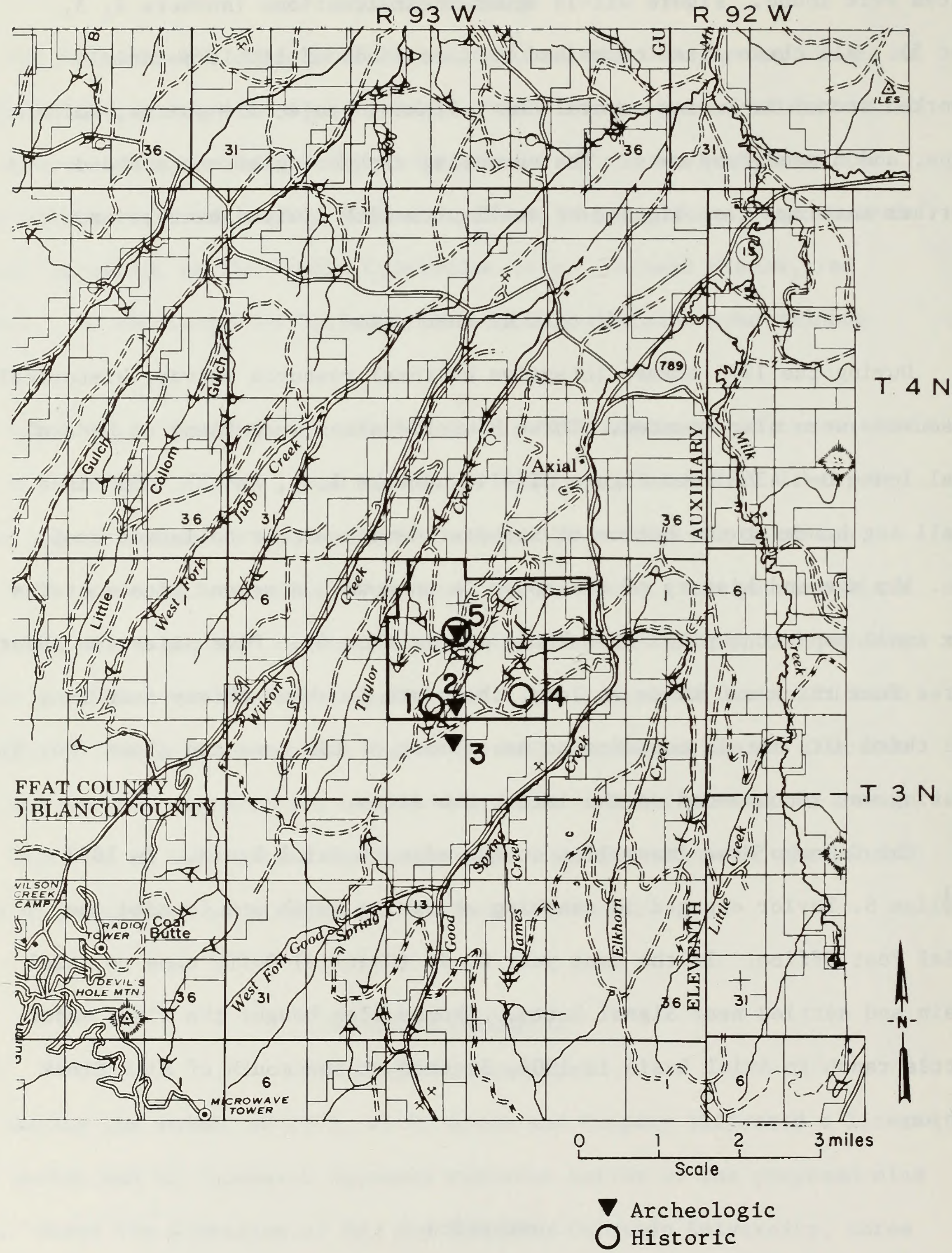


FIGURE GII-14

Cultural resources adjacent to proposed Colowyo mine site.

Portions of Federal lease D-034365 and of adjacent facility construction areas are visible from Moffat County Roads 17, 32, and 51 as well as from Colorado Highway 13.

A system developed for the Landscape Visibility study on the I-70 corridor through Colorado (Federal Highway Administration, Bureau of Land Management and Colorado Division of Highways 1974) provides an objective methodology for visual resource analyses. It enables a determination of the relative visibility of the many landscapes visible from the area's public roads. Refer to Figure GII-17 while tracing the following visual resource analysis metholodogy.

Any road traverses a visual corridor that consists of all areas visible from that road. This corridor can be divided into smaller landscapes or viewsheds that are defined by the ridges, peaks, and escarpments that surround these smaller landscapes. Though views may overlap from one viewshed to another, motorists naturally pass through successive viewsheds as they cross their respective topographic boundaries.

A single viewshed sequence is that segment of a road contained by any one viewshed. Transitional points between viewshed sequences, or viewshed sequence points, can be mapped to obtain reference points for classifying the landscape visible from each road segment.

Relative to each viewshed sequence, viewsheds may be subdivided into landscape visual units; these are determined by: (1) their distance from the viewer, (2) the combinations of viewshed sequences offering the view, and (3) the direction of travel along these viewshed sequences. Each landscape visual unit's relative visibility may be mapped accordingly.

Borrowing from the art of landscape painting, views may be classified into three picture planes or distance zones:

1) Foregrounds include that portion of the view wherein human-size features are easily discernable, as are the four visual building blocks - form, line, color, and texture (i.e. visual dominance elements). They generally lie from one-quarter to one mile beyond the viewer;
2) Middlegrounds include larger-scale landscapes such as the three-dimensional quality of landforms and patterns of cloud shadows. Overall patterns of vegetation and earth constitute texture which is no longer distinguishable in human-size features. Middlegrounds generally occur from the foreground limit up to 3-8 miles distant;
3) Backgrounds include distant landscapes where colors and texture are subdued. These landscapes often appear as silhouettes though some vegetative and geologic patterns are visible up to 20 miles.

Mapping symbols are used to identify each visual unit's relative visibility as indicated above. Though any one visual unit may be viewed from more than one viewshed sequence and therefore at varying distances, map symbols indicate its most sensitive level of exposure to the viewer.

Analysis of the landscape visibility maps will suggest areas that are more visible than others. Visibility increases at closer distances, when both number and length of viewshed sequences offering the view increase, and when the units can be viewed by motorists traveling in both directions.

Refer to Chapter IV of the Regional Analysis for a discussion of the regional aesthetic setting of the proposed Colowyo Mine as well as a general discussion of visual resources.

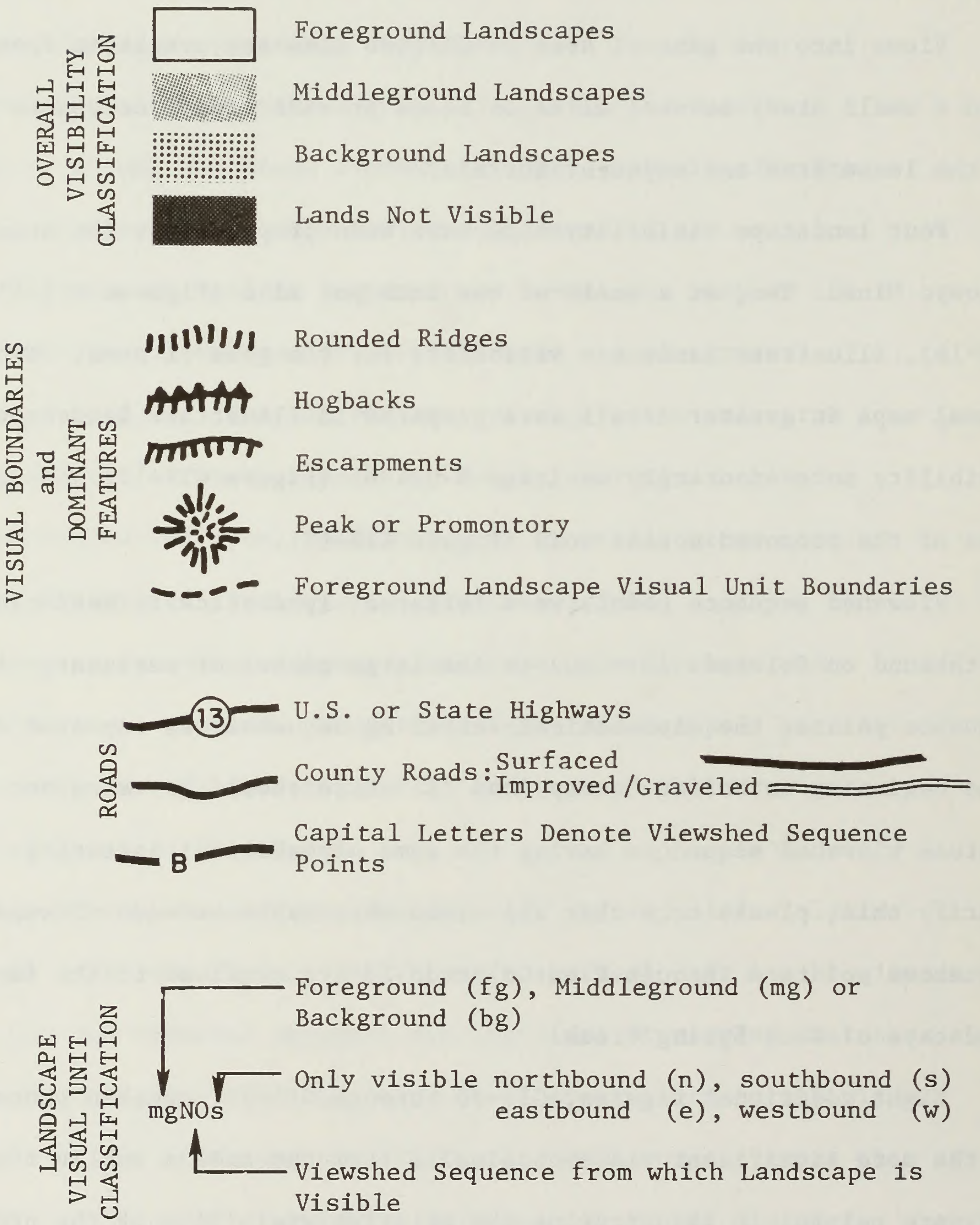
Views into the general area of Colowyo mine are available from more than a small area; several miles of roads provide visual access to portions of the lease area and adjacent terrain.

Four landscape visibility maps have been prepared for the area of the Colowyo Mine. Two, at a scale of one inch per mile (Figures GII-15 and GII-16), illustrate landscape visibility for the general area. Two additional maps in greater detail were prepared to illustrate landscape visibility more accurately on lease D-034365 (Figure GII-17) and in the area of the proposed access road (Figure GII-18).

Viewshed sequence points were lettered alphabetically beginning northbound on Colorado 13. Due to the large number of necessary viewshed sequence points, the alphabetical lettering sequence was repeated a second time beginning on Moffat County Road 32. Care should be taken not to confuse viewshed sequences having the same alphabetical lettering. To clarify this, please note that all views obtainable between viewshed sequences points A through P on Colorado 13 are confined to the immediate landscape of Good Spring Creek.

Eight additional figures, GII-20 through GII-27, contain photographs of the more significant views obtainable from the area's public roads; they are helpful in illustrating the relative visibility of the proposed action area.

LEGEND
for
LANDSCAPE VISIBILITY MAPS



OVERALL VISIBILITY CLASSIFICATION	□	Foreground Landscapes
	▒	Middleground Landscapes
	░	Background Landscapes
	■	Lands Not Visible
VISUAL BOUNDARIES and DOMINANT FEATURES		Rounded Ridges
		Hogbacks
		Escarpments
		Peak or Promontory
	- - -	Foreground Landscape Visual Unit Boundaries
ROADS	—13—	U.S. or State Highways
	—	County Roads: Surfaced / Improved/Graveled
	—B—	Capital Letters Denote Viewshed Sequence Points
LANDSCAPE VISUAL UNIT CLASSIFICATION	mgNOs	Foreground (fg), Middleground (mg) or Background (bg) Only visible northbound (n), southbound (s) eastbound (e), westbound (w) Viewshed Sequence from which Landscape is Visible

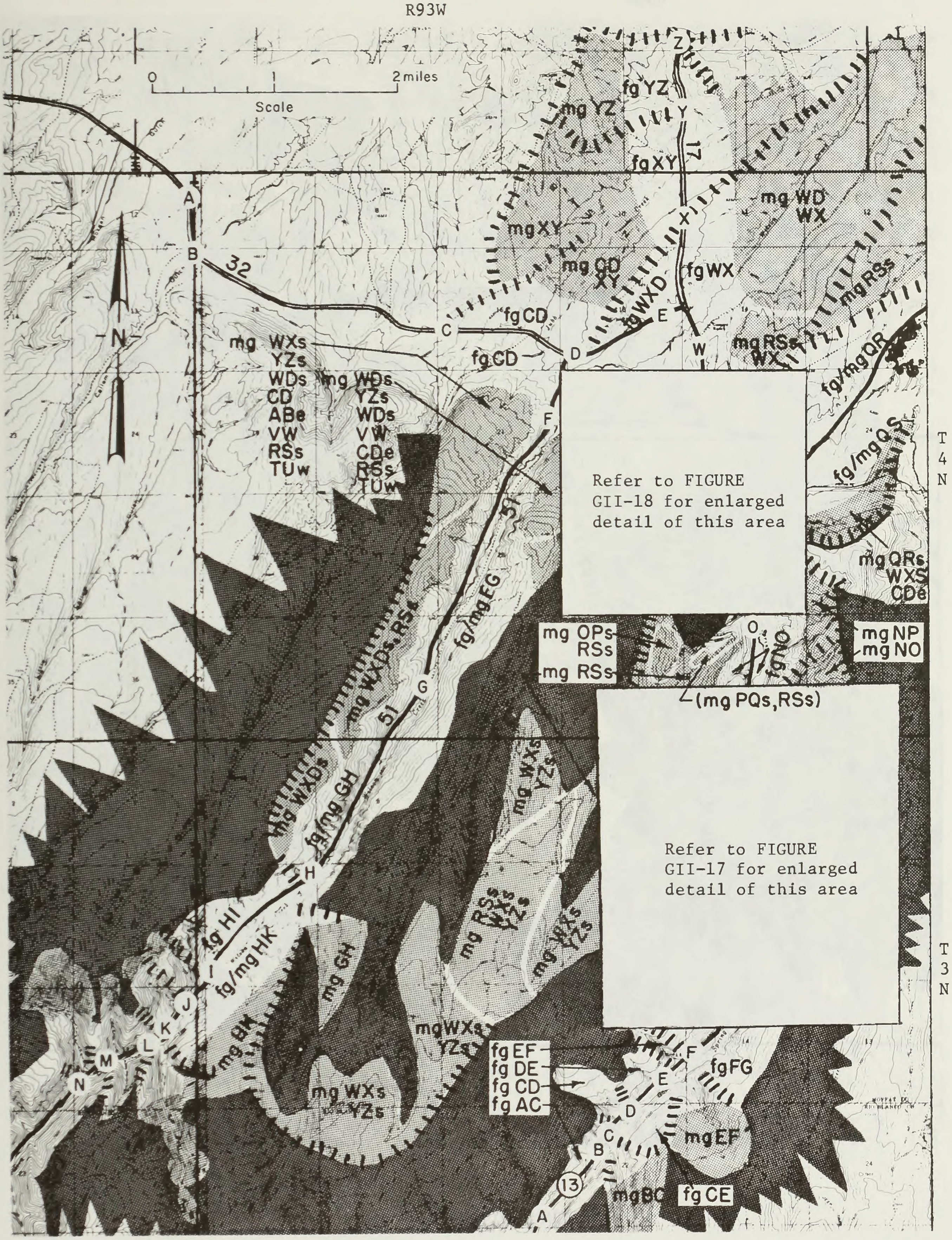


FIGURE GII-15
Landscape visibility map for W.R. Grace Colowyo mine.

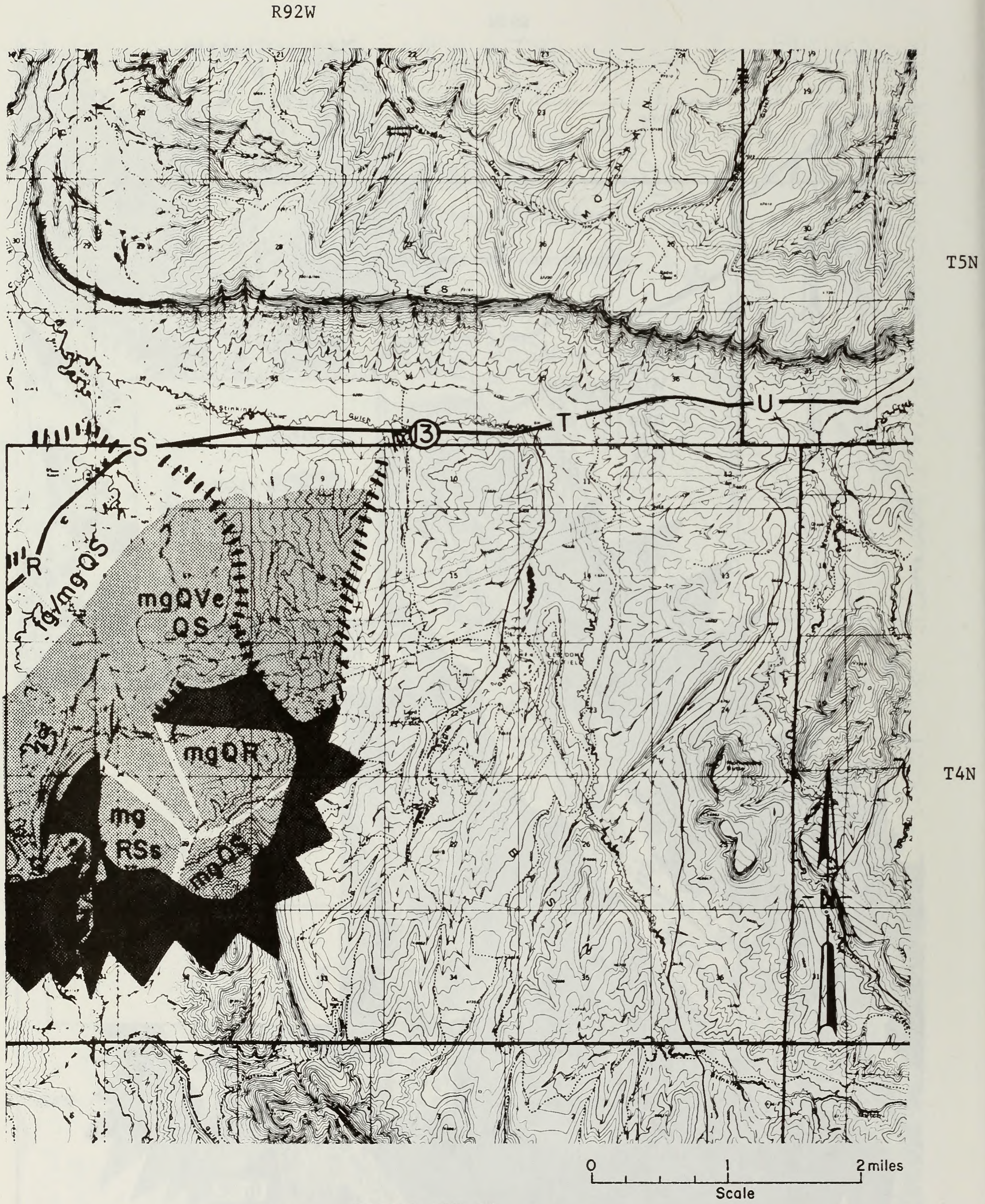


FIGURE GII-16

Landscape visibility map for W.R. Grace Colowyo mine.

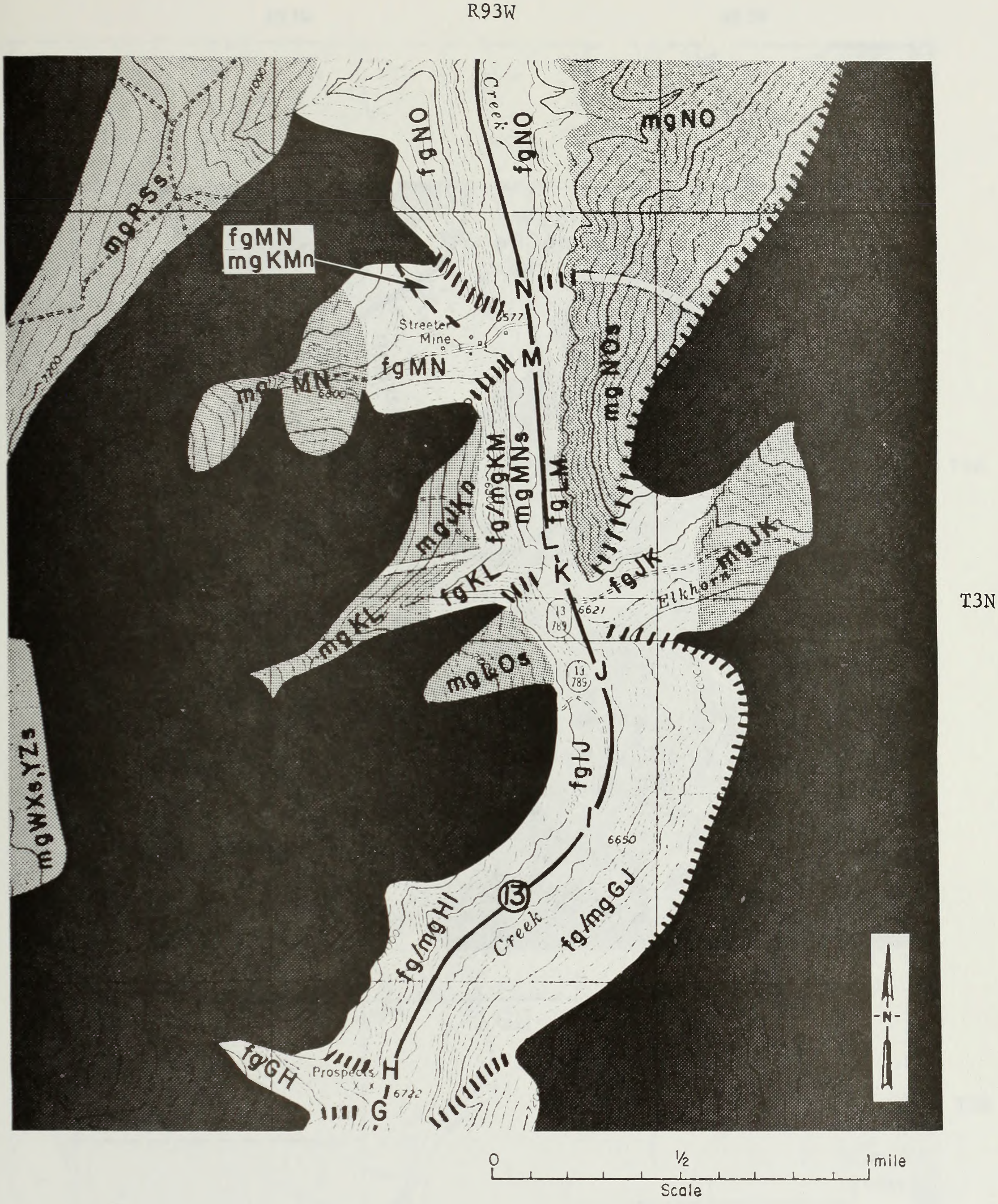


FIGURE GII-17

Landscape visibility map for W.R. Grace Colowyo mine.

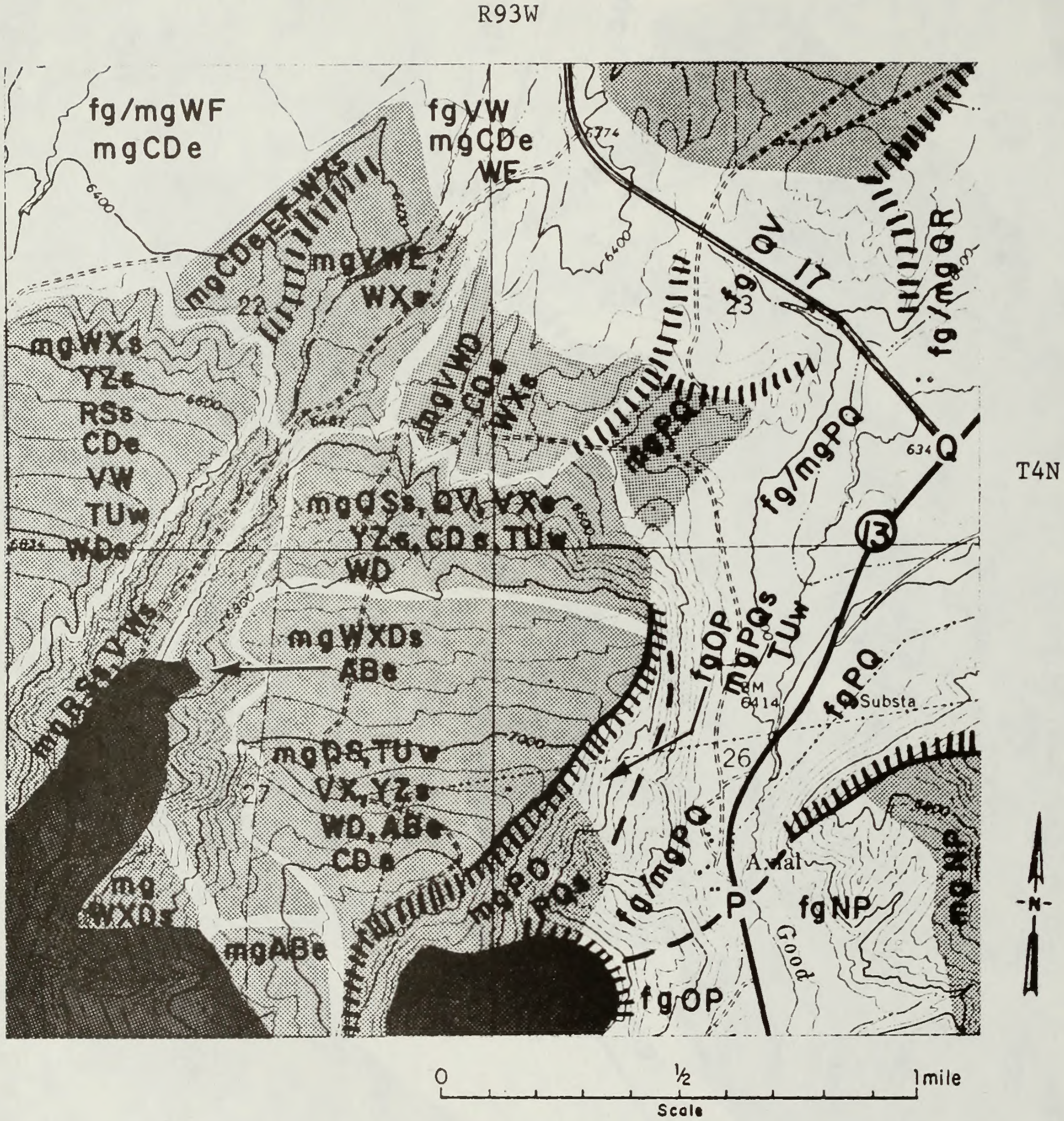


FIGURE GII-18

Landscape visibility map for W.R. Grace Colowyo mine.

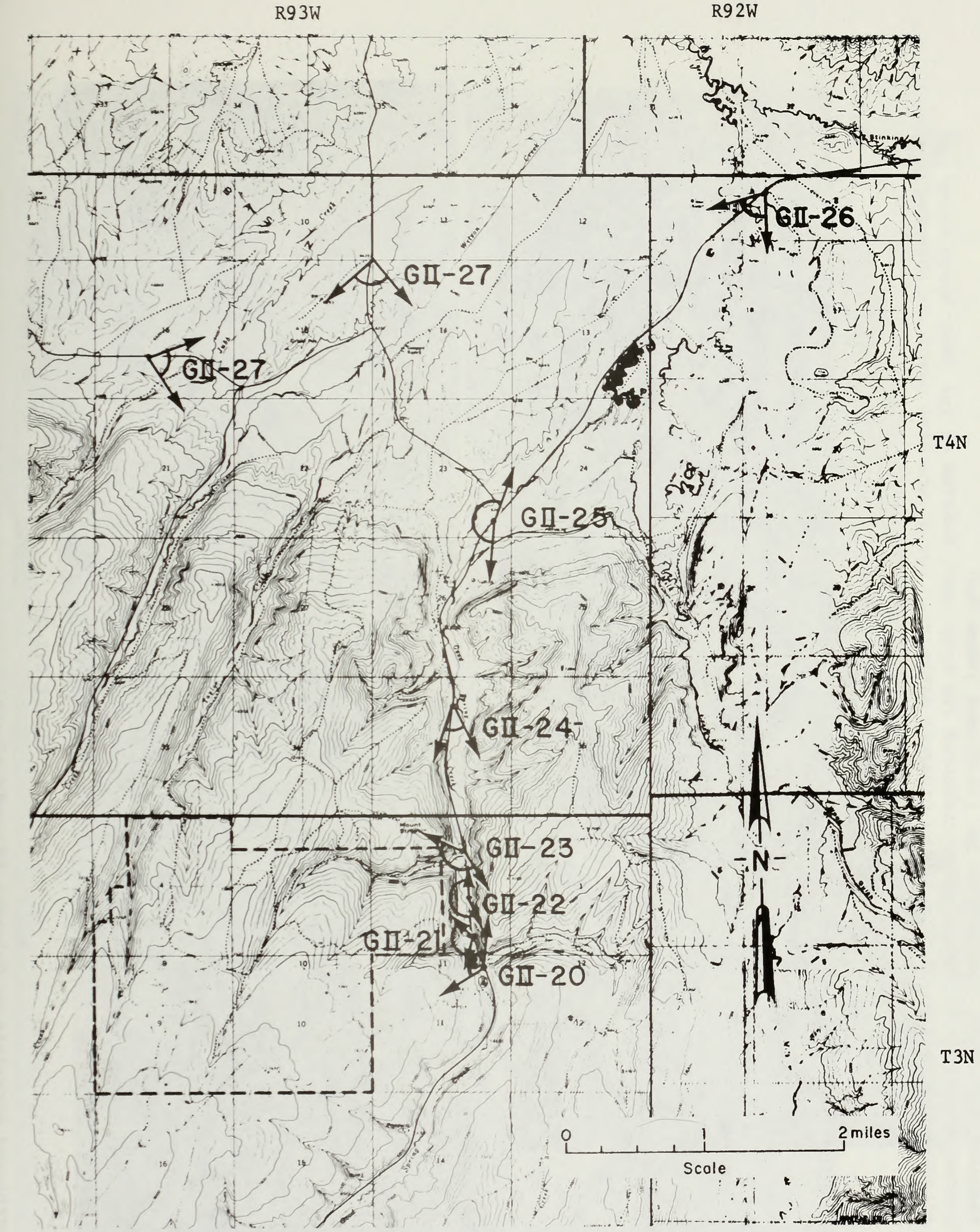


FIGURE GII-19

Locations of photo points and direction of view of FIGURES GII-20 through GII-27.

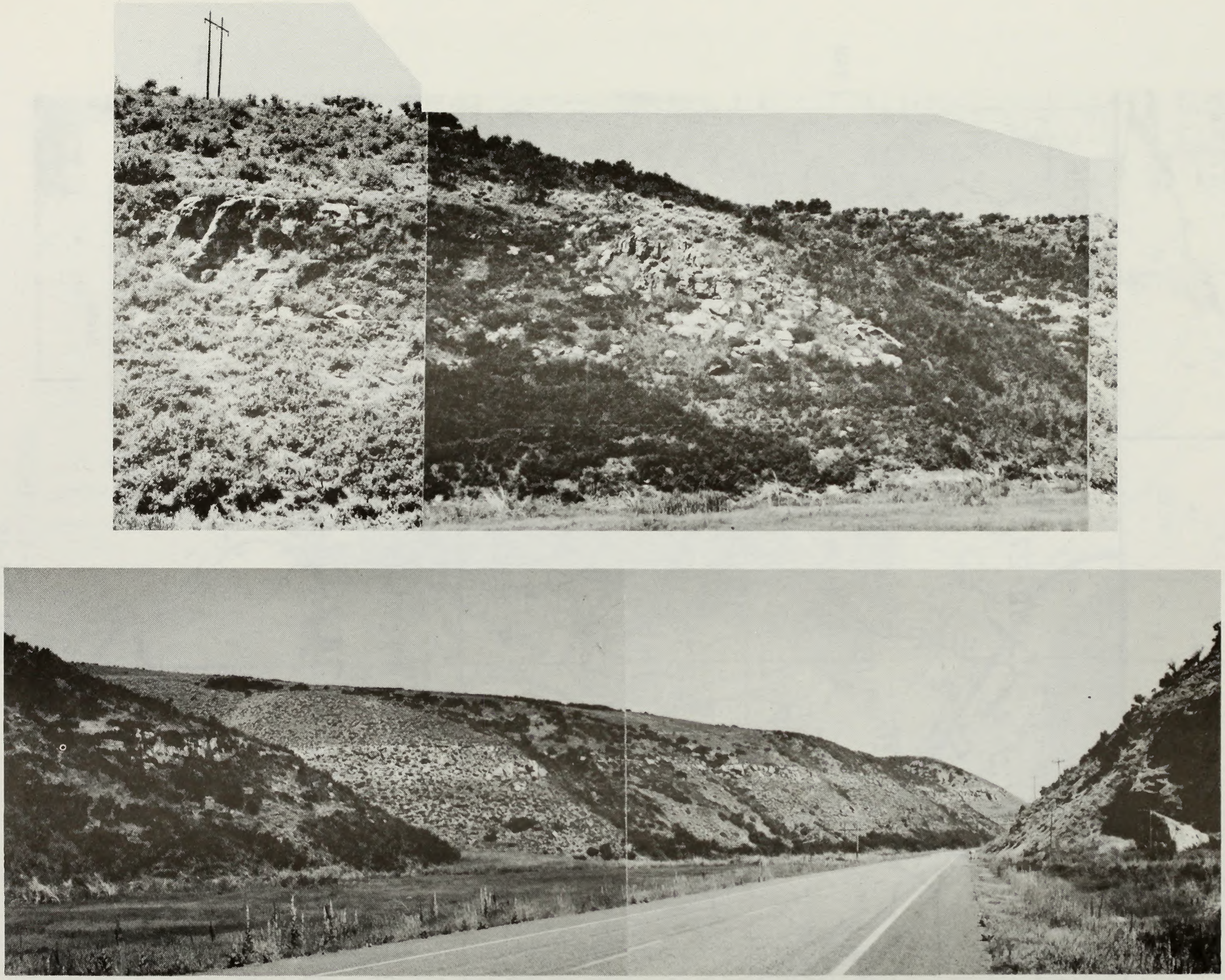


FIGURE GII-20

Northbound motorists on Colorado 13 would be able to view surface mining operations at middleground distances and at a low angle from viewshed sequence JK (see lower photo sequence).

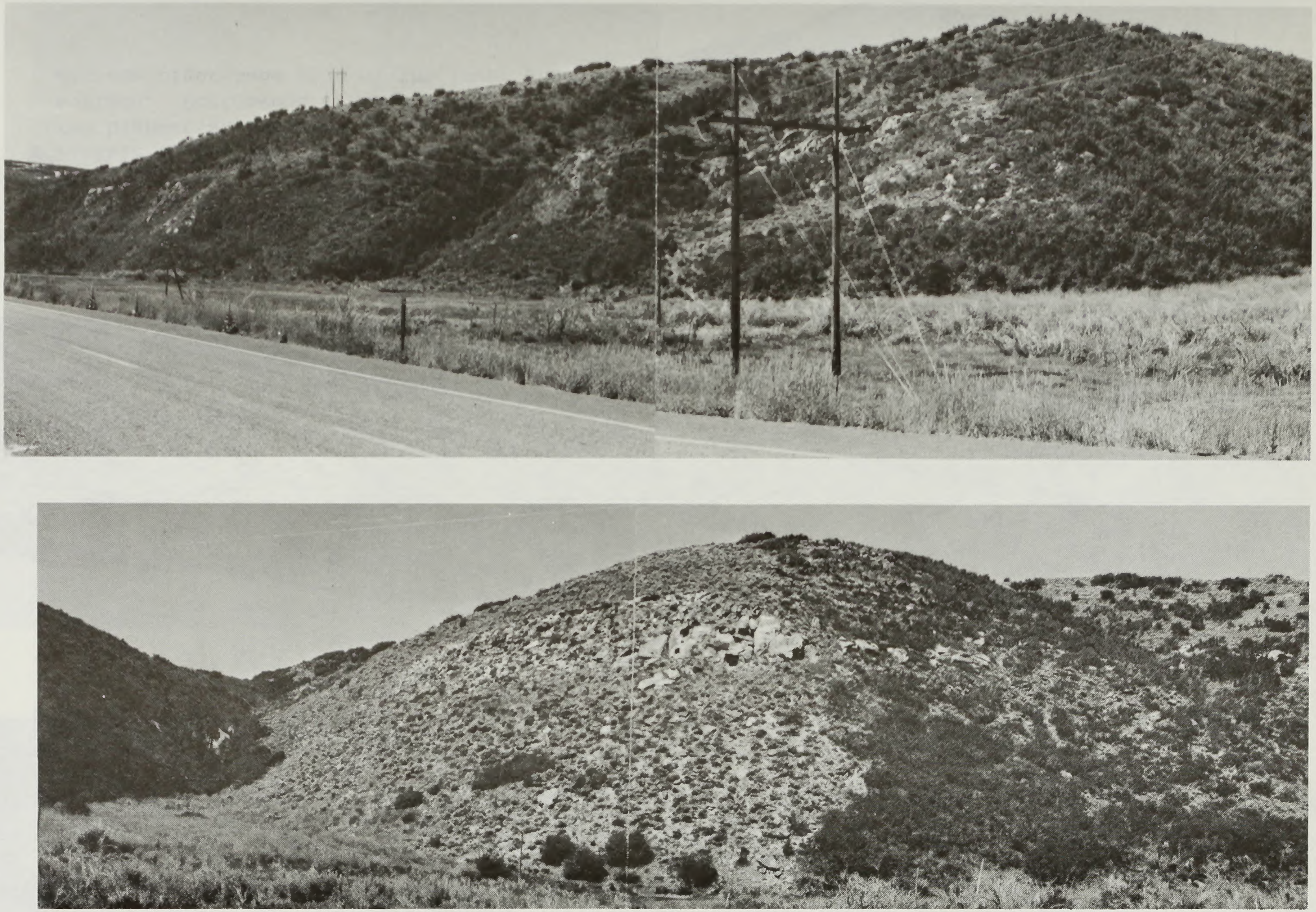


FIGURE GII-21

Viewshed sequence KL on Colorado 13 provides views into the narrow draw which the proposed 69-kv transmission line alinement would traverse; the right-hand portion of the upper photo shows the proposed substation location in the foreground landscape.

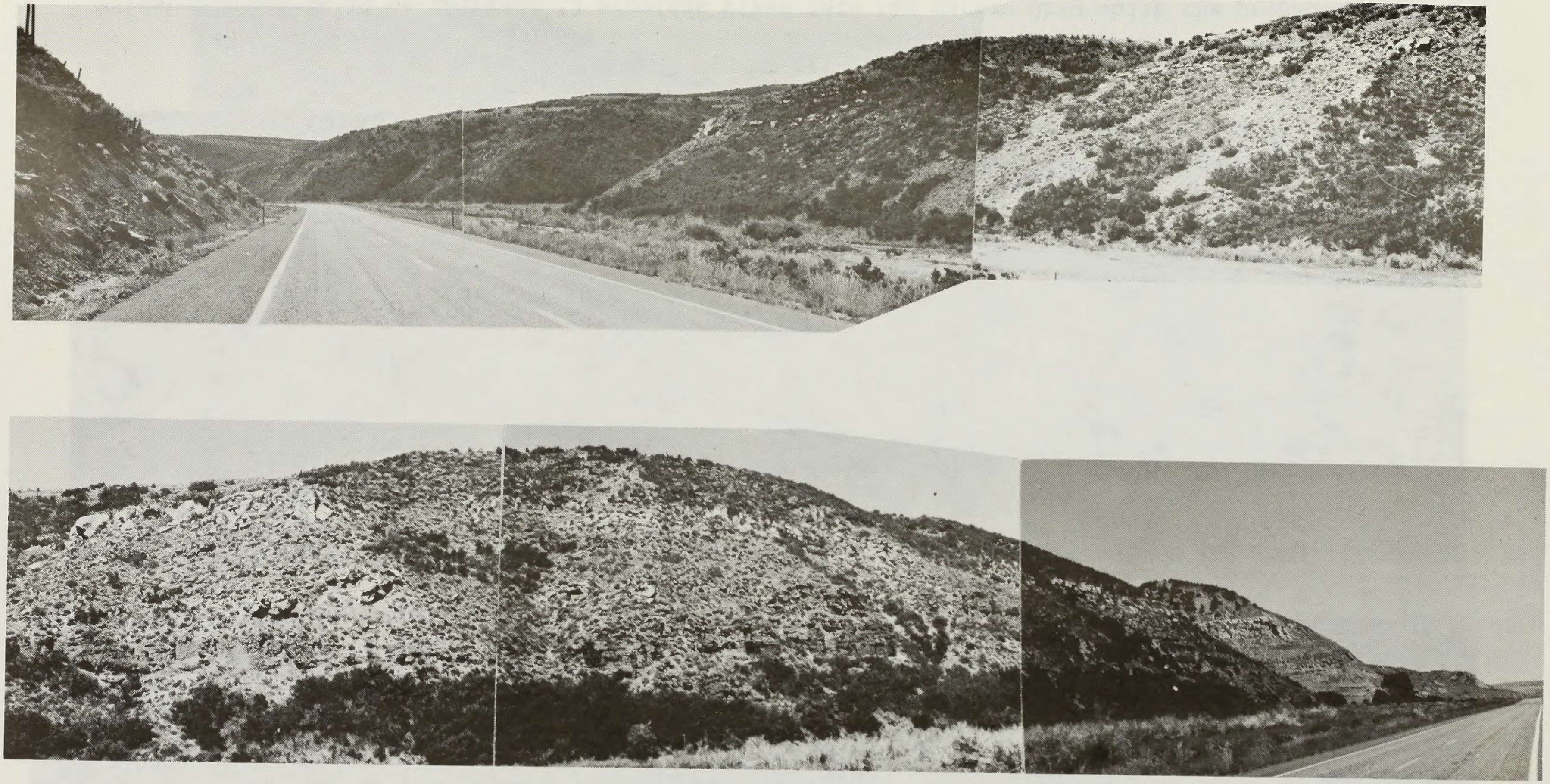


FIGURE GII-22

This six-photo sequence illustrates the landscape visible to the west of Colorado 13 from viewshed sequence LM. Proposed surface mining operations would be viewed only on the landscape unit visible on the left-hand side of the top photo sequence. The proposed haul road would parallel the highway at the crest of this foreground hillside; portions of it would be visible on the horizon. Cottonwood trees adjacent to the present Colowyo mine access road are visible on the extreme right-hand side of the lower photo sequence.

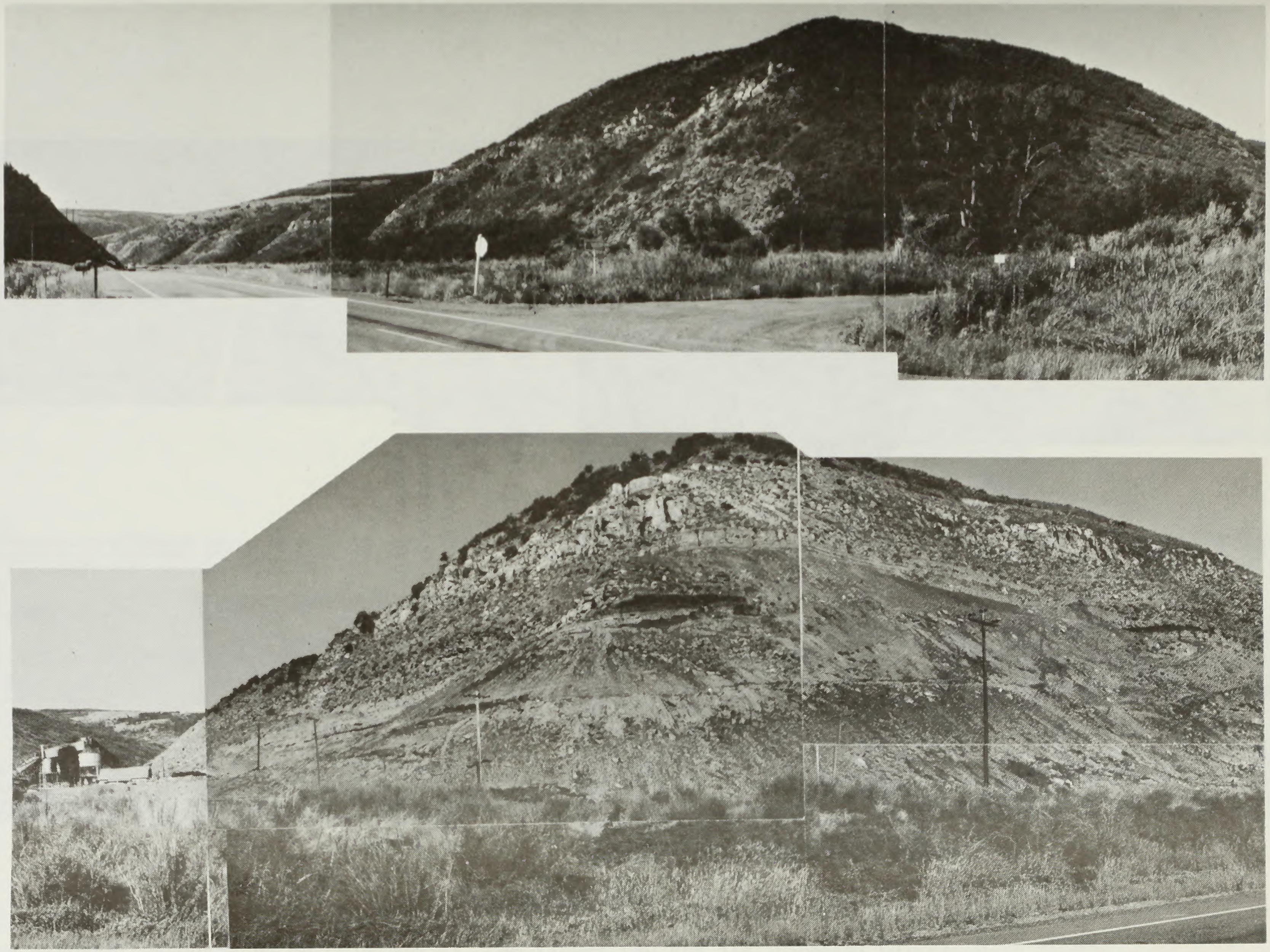


FIGURE GII-23

Viewshed sequence MN on Colorado 13 provides foreground and middleground views into Streeter Canyon; surface mining operations would be visible here as well as to the south (see left end of upper photo sequence).

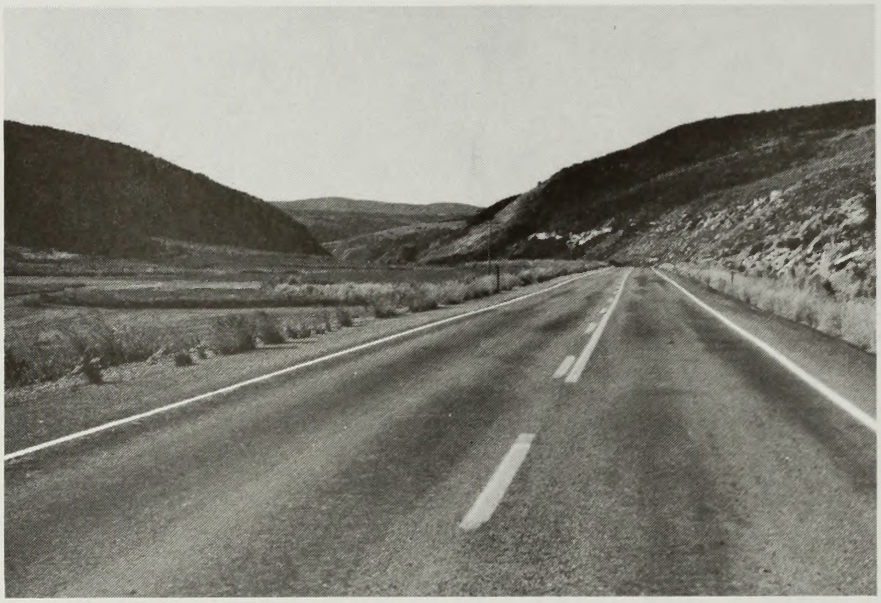


FIGURE GII-24

Southbound motorists on Colorado 13 can first view proposed surface mining operations from viewshed sequence NO (see sagebrush-covered ridge in center of photo).

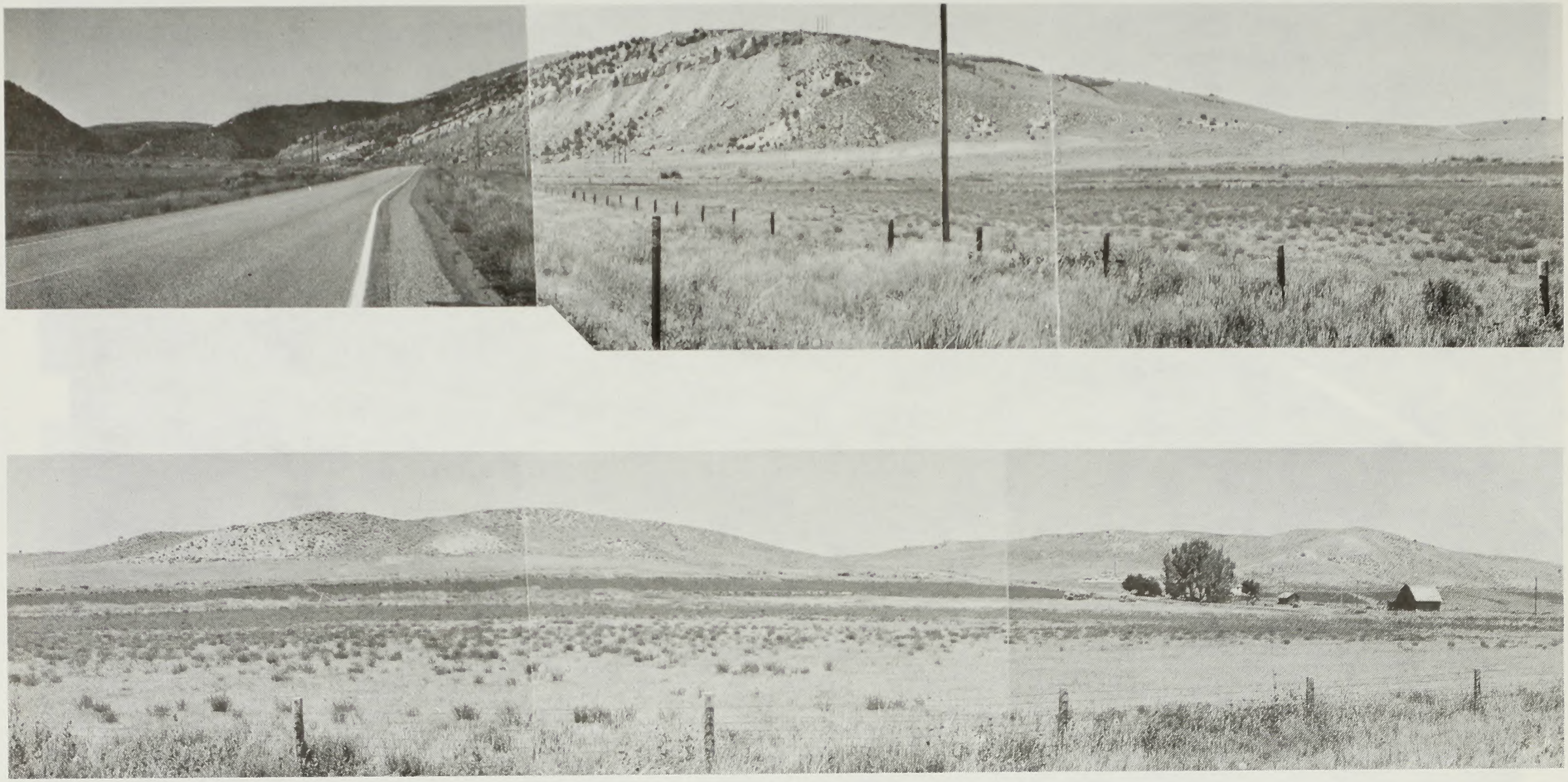


FIGURE GII-25

From viewshed sequence PQ on Colorado 13, the viewer can see the proposed Colowyo Mine access road alinement and mine office facility location to the west.

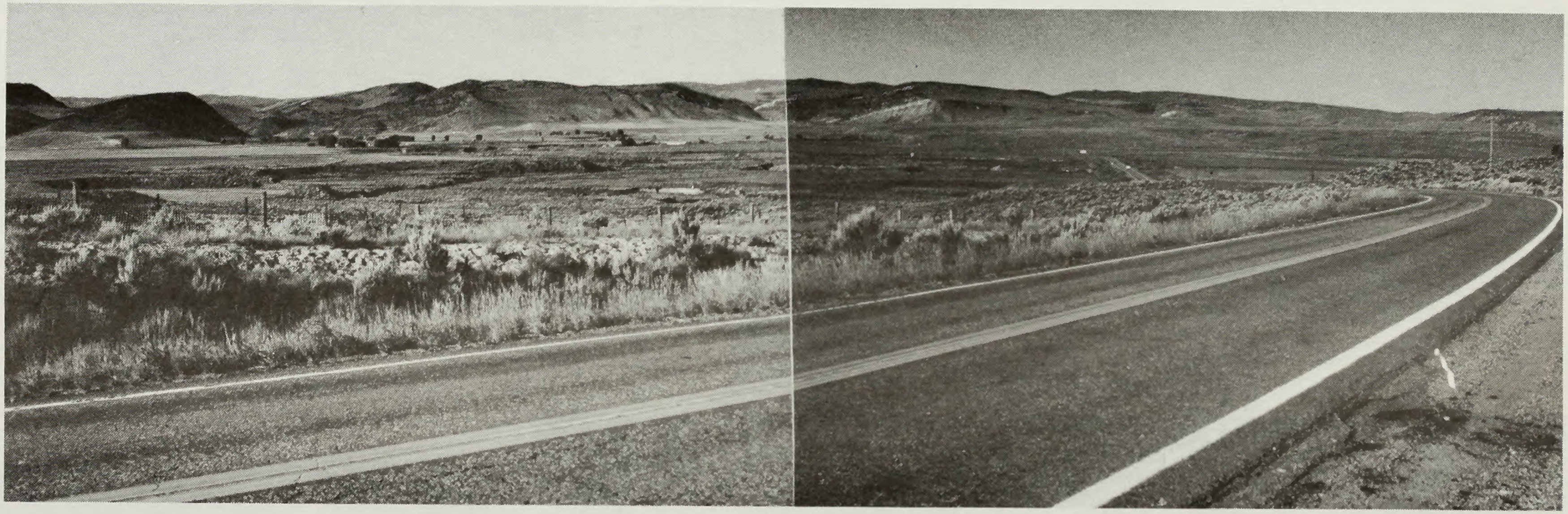


FIGURE GII-26

The proposed mine access road would be visible on the hillside just right of photo center as seen from viewshed sequence RS on Colorado 13; no proposed surface mining could be seen from this road segment.

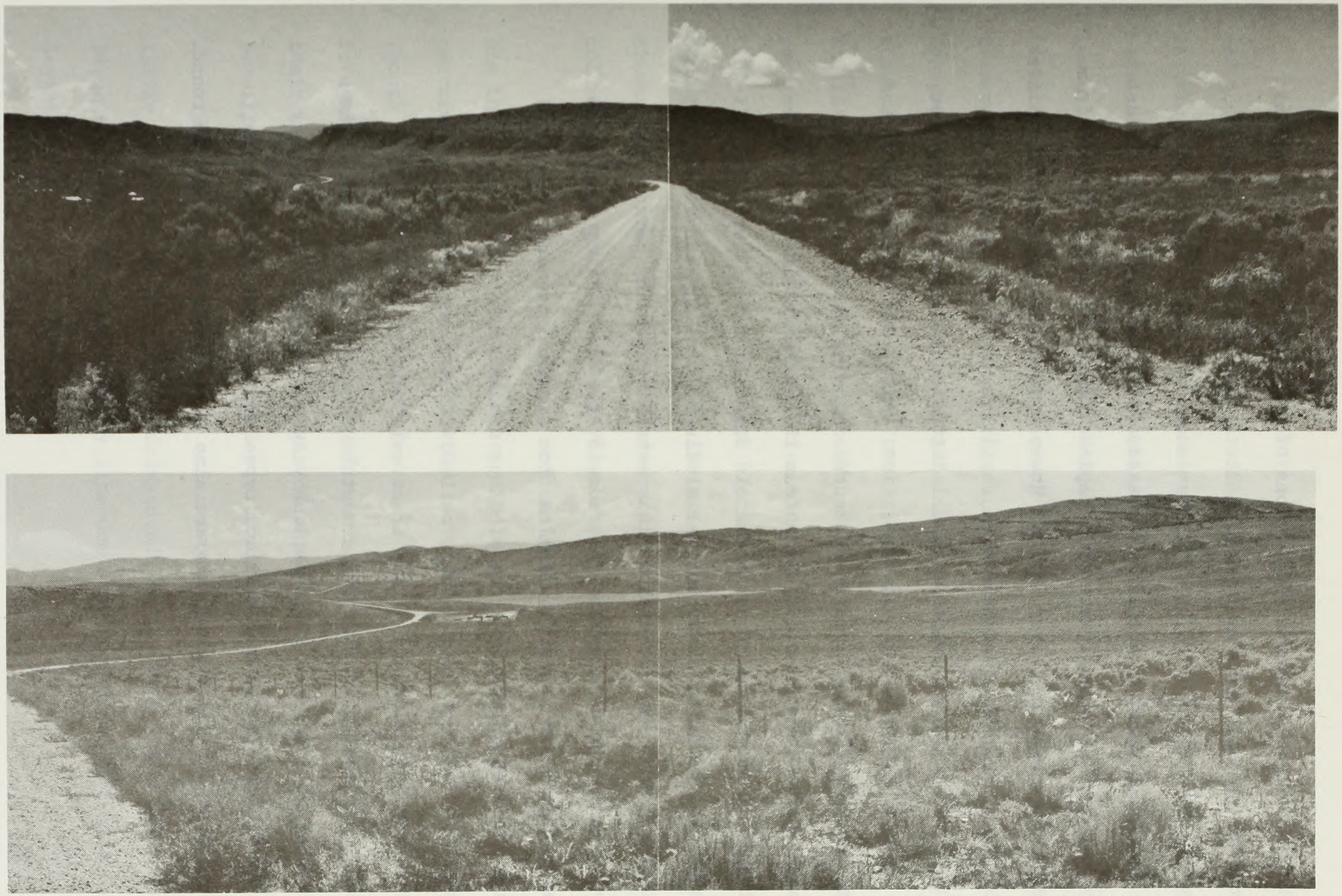


FIGURE GII-27

Two different views show the units containing the proposed access road, loadout facilities and conveyor area; the upper photo faces south from viewshed sequence WX on County Road 17 -- the lower photo faces east from sequence CD on County Road 32.

The most visually sensitive portions of Federal coal lease D-034365 are those foreground landscape visual units lying adjacent to Colorado Highway 13 (see Figure GII-17). This landscape occupies a small area of grassy floodplain that is contained by steeply rising scrub oak hillsides. Largely undisturbed natural terrain occupies foreground units visible from viewshed sequence points H through M. However viewshed sequence MN provides access into Streeter Canyon where mine facilities from the old Red Wing Mine constitute minus deviations (visual intrusions) because they do not borrow dominance elements (i.e., form, line, color, and texture) from the characteristic landscape. Viewshed sequence MN also provides views to texture and line-dominant minus deviations that have resulted from attempts to extinguish underground fires at the old Streeter mine (see Figure GII-23).

Lease area D-034365 also contains middleground landscape visual units that are less visible and therefore less sensitive. Lying beyond the foreground landscape adjacent to Colorado 13 are four middleground units that may be viewed at rather low angles from viewshed sequence points J through O. These areas are free of minus deviations.

Other middleground visual units on D-034365 may be viewed at greater distances from Moffat County 51 and 17 as well as from Colorado 131. Viewshed sequences WX and YZ provide southbound travel with views of the upper reaches of lease D-034365, as does viewshed sequence RS. Largely natural rolling sagebrush and woodland types occupy these visual units, though exploration trails and roads are also discernible in the middleground.

Landscape visibility maps for the area of the proposed mine office and access road are found in Figure GII-18. Foreground landscape visual units visible from viewshed sequences OP, PQ, QV, VW, and WD are the more sensitive areas. They contain combinations of flat meadow and range lands, rolling sagebrush hills, steeper pinyon-juniper hillsides, and rimrock escarpments. The townsite of Axial plus two existing electric transmission lines occupy the foreground landscape of viewshed sequence PQ. The powerlines and to a lesser degree the buildings at the townsite, constitute minus deviations resulting from strong line and color dominance. Ranches occupy viewshed sequences QV and WX. Though they are an integral part of Axial Basin's ranching lifestyle, their buildings produce deviations from the characteristic landscape. Earth-tone colors and subtle forms of some of these buildings are plus deviations in that they borrow dominance elements from the characteristic landscape. The silhouetted and bright colored buildings are generally viewed as minus deviations.

Landscape visual units that define Axial Basin's southern perimeter are this area's most visible units. The easternmost hillside which will contain the Colowyo Mine access road is visible from seven viewshed sequences. Though elements in this landscape are of smaller scale than those in foreground units, their potential for being viewed repeatedly increases their sensitivity. A greater angle of exposure to the viewer also increases sensitivity in terms of increased visibility of potential minus deviations.

The hillside to contain the access road presently contains a 138-kv transmission line and an unimproved trail. Though the trail is largely unnoticable, the strongly line-dominant powerline is a minus deviation.

Views from Moffat County Road 55 in the Government Bridge area (south of Lay, Colorado) reveal background landscape visual units on the highly exposed hillsides above Axial and on the upper reaches of lease D-034365. As they lie some 14 miles apart, these viewshed sequences and corresponding landscape visual units were not mapped. However these viewpoints do lie below the proposed highwater line at the proposed Juniper Reservoir (6,110 feet). This indicates background visibility for portions of Colowyo mine area to potential reservoir users.

Visual analyses were made only from surfaced or improved and graveled county roads. Therefore views from Moffat County 133 and 88 were not analyzed.

Traffic volume data are available only for Colorado 13 (see Chapter II). Sampling for 1974 indicated an average daily traffic (ADT) volume of 730 vehicles. This reflects an average annual increase of 14.2 percent since 1970, compared to only a 2.5 percent increase for the five-year period preceding 1970.

Recreation

Refer to Chapter IV of the regional analysis for a discussion of the existing recreation environment. The following paragraphs outline more specific recreation resources and their current use in the area of the W. R. Grace Colowyo mine.

Resources

Though no big game concentrations occur on Federal coal lease D-034365, the area does offer winter viewing opportunities for deer. Especially on the open southerly-exposed sagebrush slopes (see Chapter II, Aesthetics, for areas visible from public roads), deer may be viewed by motorists traveling Colorado Highway 13. Dense mountain shrub cover largely precludes distant wildlife viewing at higher elevations.

Private surface ownership prevents guaranteed public hunting on the mine site; no private recreation operations occur on the site. About 80 acres of national resource lands lie within the lease boundaries, though no access is maintained to the area as it is blocked by privately owned surface acreage. See Chapter II, Terrestrial Fauna, for a more complete description of wildlife resources.

No fisheries occur on the mine area, though significant fisheries do occur downstream (Regional Analysis Chapter IV). Axial Basin Reservoir and Milk Creek have a moderately low fishing capability (Bureau of Land Management 1974). See Chapter II, Aquatic Fauna, for a more complete description of fisheries.

The Bureau of Land Management's (BLM) Williams Fork land-use plan contains an analysis of the land's capability to attract and accommodate recreation use. Figure GII-28 displays relative inherent capabilities of the various land units surrounding the proposed mine area. This rating pertains to existing resources and does not imply management.

Existing recreation developments

No private nor public recreation developments lie on the proposed mine area. Axial Basin Reservoir is cooperatively managed by Moffat County in conjunction with the local 4-H group and is owned by Milliken Land and Cattle Company (Regional Analysis, Chapter IV); it has a moderately low capability to attract and sustain fishing use.

Recreation Capability Classification

Legend for Figure GII-27

I. Capability Classes:

(Capability to attract and to accommodate recreation)

Class 1 - Very high; intensive activities
2 - High; intensive activities
3 - Moderately high; intensive activities
4 - Moderate; dispersed activities
5 - Moderately low; dispersed activities
6 - Low; dispersed activities
7 - Very low; dispersed activities

II. Sub-Classes:

(Recreation resources)

A - angling
E - interesting vegetation
K - organized camping
M - small water bodies
O - viewing upland wildlife
P - agricultural interest
Q - topographic - landscape variety
R - rock formations
V - panoramic view
W - waterfowl viewing
XS - snowmobiling

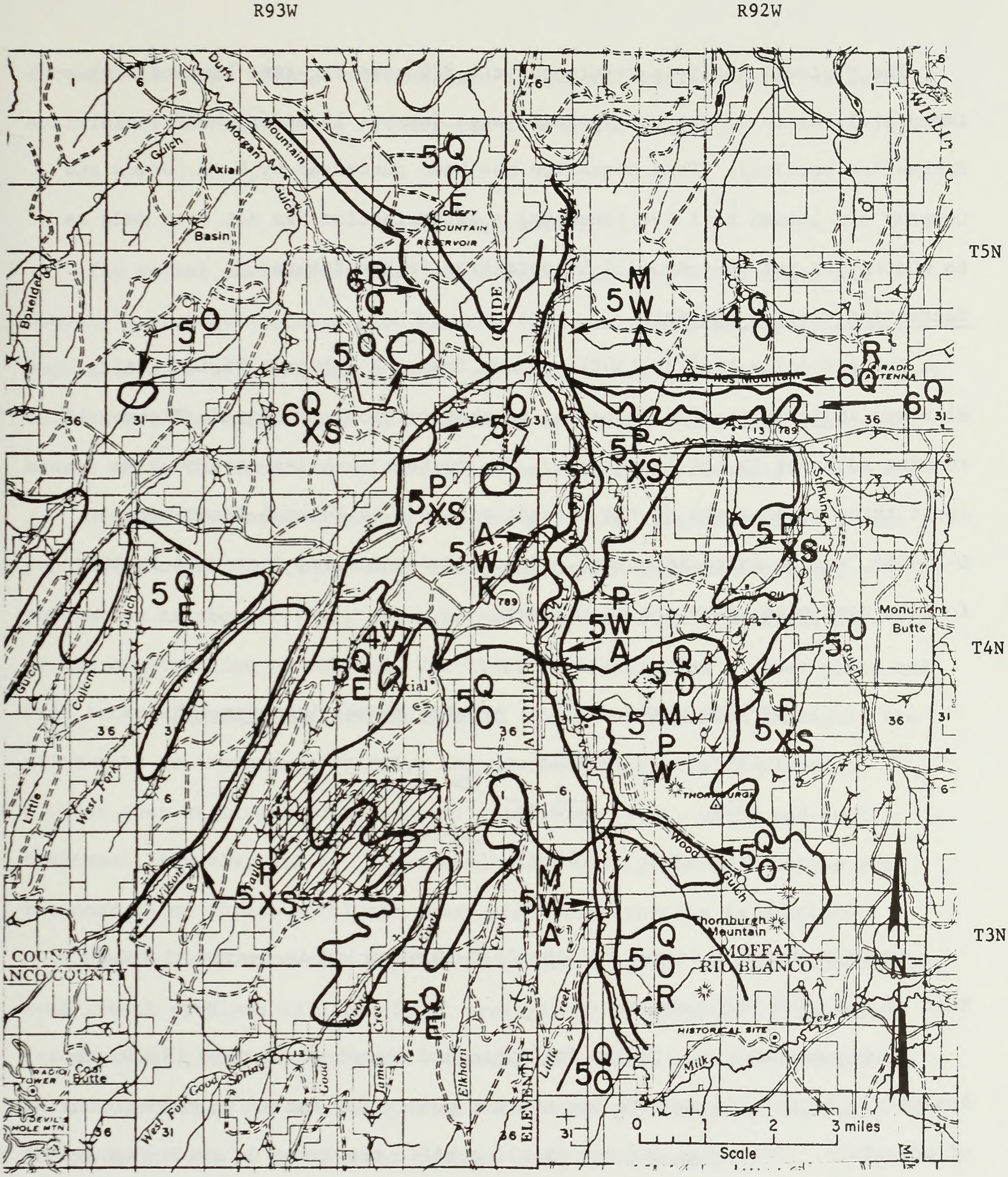


FIGURE GII-28

Recreation capability classification for the W.R. Grace Colowyo mine area.

SOURCE: Bureau of Land Management, Williams Fork URA, 1974

The Regional Analysis references a 6,370 acre big game hunting area immediately north of the Colowyo mine area (number 19 under the Private Recreation section). This operation has been purchased by W. R. Grace and Company and leased back for ranching; a determination has not been made as to whether or not hunting will be permitted in the future.

Recreation visitor-use data

Average daily traffic (ADT) volumes from the Colorado Division of Highways indicate traffic increases on that portion of Colorado Highway 13 running adjacent to the lease area. The nearest sampling station lies about three miles south of the present entrance to Federal lease area D-034365, and no exits intervene. Compounded annually, increases in ADT for the past nine years are as follows:

Sampling year	ADT	Average annual increase (%)	
1965	380		
		2.50	
1970	430		7.52
		14.15	
1974	730		

Average annual increase for the 1970-1974 period is nearly sixfold that of the 1965-1970 period.

Origin-destination studies for Rifle and Steamboat Springs (Regional Analysis, Chapter IV) provide the nearest points for analyzing composition of motorists. Forty-two percent of all traffic traveling Colorado Highway 13 north of Rifle, and an average of 29.5 percent of all U.S. 40 traffic through Steamboat Springs were engaged in general recreation or vacation activities. No additional visitor-use data are available.

Social Environment

The social environment that would be affected by W. R. Grace and Company's proposed Colowyo mine extends from the immediate, sparsely populated area of Axial Basin north and east to Craig and Hayden, and south to Meeker. The Axial Basin is a ranching area with fewer than ten ranch houses while the community of Axial has only three residences.

Of the three other communities, Craig is the largest with a current population of about 6,000. Both Craig and Hayden (Hayden's current population is about 1,700), are experiencing boom town conditions now, due to the construction of Colorado Ute Electric Association's power plant and Utah International's surface coal mine. The housing market is tight; the crime rate is increasing sharply; and new demands are being placed on already over-utilized social support facilities (e.g., water and sewer treatment, schools, etc.). These conditions will probably continue over the next three years, until the power plant construction is complete.

Meeker, with a current population of about 1,800, is also encountering some growth problems as a result of preliminary development of oil shale resources in the Piceance Basin. Housing shortages, increased crime, and increased demands for social support facilities will continue in the future as oil shale development reaches commercial stages.

For a more extensive analysis of the social environment, refer to Chapter IV of the Regional Analysis.

Economic Conditions

In the area that will be affected by the development of the Colowyo mine, the industrial sectors employing the most people are agriculture, retail trade, and construction. In the future it is expected that the mineral-extracting sectors will gain importance as the development of non-coal related energy resources proceeds. Currently the agricultural sector generates the vast majority of earnings in the area, but in the future, earnings in the minerals extractive industries (other than coal) will expand rapidly.

The standard of living in the area, measured in terms of 1973 per capita personal income, is about $4,700, approximately six percent less than State and national averages. This difference from State and national levels is probably the result of the lack of a strong manufacturing sector which traditionally is a high income industry.

For a more extensive analysis of economic conditions, refer to Chapter IV of the Regional Analysis.

Transportation Networks

Highways

At the present time, the general area of the W. R. Grace Colowyo mine site near Axial, Colorado is served by Colorado Highway 13 running south from Craig, Colorado and Colorado Highway 317 from Pagoda running west, connecting with Colorado 13 at Hamilton, Colorado.

Colorado 13 has been improved for use in hauling coal between the site of the existing Empire Energy mine near Hamilton and Craig; south of this point, the road has not been improved. There are three bridge which also have not been strengthened for heavy lodas. These bridges include the Milk Creek bridge eight miles south of Hamilton (no posted weight limit), the Stinking Gulch Bridge, 5-5 1/2 miles south of Hamilton (39 ton gross weight), and another unnamed bridge 6-6 1/2 miles south of Hamilton (33 ton gross weight).

Highway 13 is a two-lane paved road throughout its length and Highway 317 is a narrow surfaced road over the length mentioned above. These roads, where not significantly improved, are basically designed as light vehicle roads.

Highway 13 at the present time passes quite close to the W. R. Grace mine site at Axial. There would be no barriers, during haul road construction, to prevent any overburden or coal loss from rolling downhill to the surface of Colorado 13.

Railroads

There are no existing rail lines into the area of the W. R. Grace Axial mine site. The closest rail facility that can be considered existing is a planned D&RGW railroad spur (to a Colorado Ute plant site) running southwest of Craig, Colorado. Contracts have been let for this planned construction; it will connect with the existing D&RGW branch line running east from Craig, Colorado.

Airlines

The closest airport to the W. R. Grace mine site is the Craig Airport, which has somewhat limited services. Another close airport is the Yampa Valley Airport southeast of Hayden, Colorado. It is regularly served by Frontier Airlines and is now undergoing a 10-million dollar improvement program.

Chapter III

Environmental Impacts of the Proposed Action

THIS CHAPTER ANALYZES IMPACTS OF W. R. GRACE & COMPANY'S PROPOSED MINE AND RECLAMATION PLAN ON THOSE RESOURCE VALUES DESCRIBED IN THE PRECEDING CHAPTER. IT IS ASSUMED IN THIS CHAPTER THAT NO EFFORTS WILL BE MADE TO MITIGATE IMPACTS. IN THIS MANNER ALL PROBABLE IMPACTS CAN BE IDENTIFIED AS THE BASE FOR THE DETERMINATION OF MITIGATING MEASURES AND UNAVOIDABLE ADVERSE IMPACTS IN THE TWO SUCCEEDING CHAPTERS. WHERE DATA ARE AVAILABLE, IMPACTS ARE LINKED TO SPECIFIC ASPECTS OF THE PROPOSED ACTION AND ARE QUANTIFIED AS TO MAGNITUDE, INTENSITY, DURATION, AND INCIDENCE. ALTHOUGH THE PURPOSE OF W. R. GRACE & COMPANY'S RECLAMATION PLAN IS TO LESSEN ADVERSE CONSEQUENCES OF SURFACE DISTURBANCE, THE IMPACTS RESULTING FROM IMPLEMENTATION OF THEIR PLAN ARE ADDRESSED IN THIS CHAPTER.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

Non-living Components

Geologic and Geographic Setting

Topography

The proposed company plan would result in an active open-pit coal mine for a few decades. This would mean that the attendant high walls, ramps, access roads, drainage ditches, and other mine workings would gradually replace the natural valley, slopes, and upland. The entire works would move slowly southward; reclamation would follow it. At the end of the 30-year mining period this process should result in a more subdued, gently sloping form. Streeter Creek's lower valley would become slightly shallower, retain its steep north side, but have a more gently sloping south side. Streeter Creek upper valley is the western boundary of the mine site and would retain its present course. Other natural drainages on the present mine site would be obliterated and replaced by man-made drainages where necessary.

Mine plans show that the company would disturb approximately 45 acres of land annually with an equal number reclaimed each year. This figure may be derived from the following computation after calculating that a total of 1,280 acres will be surface mined.

$$\frac{\text{1,280 acres surface mined}}{\text{30-year mining plan}} = \text{43 acres/year}$$

This figure may be checked for proper order of magnitude as follows:

Given: 59.4 feet total coal thickness to be mined, 3,000,000 tons per year to be produced, 90 percent recovery of coal mined, 1,800 tons/acre-foot, average weight of bituminous coal:

Then: 1,800 x 59.4 = 106,920 tons/acre

3,000,000 tons = 90% of 3,333,333 tons, total coal stripped per year (original reserves)

$$\frac{3,333,333}{106,920} = 31.18 \text{ acres.}$$

The figure of 31+ acres would hold the stated amount to be mined annually, provided the entire coal zone is present. However in the northern and eastern parts of the site much of the coal has been removed by erosion on the hill slopes. Also, the boxcut spoil area in Streeter Canyon and drainage ditches must be included in the area disturbed by mining. Thus the average figure of 45 acres that would be disturbed/year seems reasonably accurate.

In a letter of July 15, 1975 to the Area Mining Supervisor of the U.S. Geological Survey, the company states that

> The topography of the reclaimed surface will reasonably conform to the existing slopes, being feathered into the contiguous natural surface with concave and convex surfaces designed to recreate a variety of micro-environments.

The company's mining plan stated that the "approximate original contour will be returned to the mine site." The present northward slope of the surface in S 1/2 NW 1/4 and N 1/2 SW 1/4 Section 2, and S 1/2 NE 1/4 and N 1/2 SE 1/4 Section 3 are too steep for thick spoil fills. The present surface grade here ranges from 20 to 60 percent with a maximum of 100 percent.

A potential problem is whether at mining end, volume replaced throughout the mine site would be greater or lesser than present volume. No figures are available for the amount of expansion as the naturally layered bedrock is converted to mine spoil containing large fragments of randomly oriented rock. However, comparing the spoil to poorly sorted natural gravels that contain large amounts of sand, silt, and clay leads to the rough estimate of perhaps 10-20 percent porosity in the mass, thus expansion of the volume by 10-20 percent. Measurements at 28 evenly spaced points on three cross-sections furnished by the company gave an average figure of about 320 feet for depth of material moved including 59 feet of coal. Coal actually removed from the site by mining will be only about 52 feet, due to the estimated 10 percent loss in mining and coal already lost by natural erosion along the present hillsides. If the coal produced and removed from the mine site, 52 feet in thickness, is deducted from the total average depth mined, 320 feet, there would be an average of 268 feet of overburden (original thickness) to be replaced in the mine site. From the 10-20 percent expansion factor estimated above, a working estimate of perhaps 15 percent expansion of overburden materials may be assumed.

Thus: 268 ft. (average thickness of original overburden)
+40 ft. (15% expansion)
308 ft. (average thickness of final fill)

320 ft. (average original total thickness including coal)
-308 ft. (average final thickness)
12 ft. (average lowering of altitude of surface)

If this estimate is accurate, the volume of material returned to the mine site would be within 96 percent of the original volume $\left(\frac{308}{320} = 0.9625\right)$

Thus the approximate original topography may be reconstructed; however, the partial filling of Streeter Canyon would change its physical character.

Indications from the company's maps are that mining would continue far enough east in Sections 2 and 11 that when the spoil is replaced on the hills overlooking Good Spring Creek and State Highway 13 it would form a higher hill. This spoil would be continuous with the natural bedrock, alluvium, and colluvium on the lower slopes which are in equilibrium with the present environment. However the mine spoils would not initially be in such a state of equilibrium. This could lead to such problems as erosion, mudflows, or landslides if these materials become saturated with water during periods of very high rainfall or rapid snowmelt.

Company maps show drainage ditches along the contour and uphill from the mine to protect it from surface water during snowmelt or rainfall. However these ditches are shown ending short of the natural drainageways into which they are to conduct runoff waters, particularly the draw that empties into Good Spring Creek in S 1/2 Section 2. This could lead to gulley erosion downhill from the end of the ditch, and sedimentation below, with the formation of small alluvial fans in some places.

Stratigraphy

The coal-bearing Williams Fork Formation changes laterally so each area is somewhat different in its strata. Removal of a few hundred feet of strata by mining would result in a permanent loss of that part of the geologic record present in this mine area.

Structure

The record of the mined area structure would be obliterated because of deep stripping; the present structure is near and partly on the axis of the Collom syncline.

Geomorphology

The landforms resulting from the proposed mining plan would be those of an active and slowly moving strip mine, modified by reclamation methods.

These landforms would differ somewhat from original natural ones and from surrounding landforms. The ultimate land surface of the northern half of the mine area would probably have a more concave contour than the present strongly convex one. The upland surface may have a slightly greater northward slope than at present. The entire surface would have a finer-grained, slightly rolling or undulating aspect.

Possible geologic hazard

A potential mining hazard is inherent in the mining plan. Mining is to begin at the foot of a steep slope and down-dip from dipping beds. However, the structural geologic map submitted by the company shows an overall dip from three to ten degrees on Federal coal lease D-034365.

Paleontology

Impacts to the human-interest value of fossils would occur as they are removed in the coal mining operation. Given the area's lithologic character, it is likely that at least some fossil destruction would occur.

Mineral Resources

The mining plan submitted by W. R. Grace calls for 30 years of mining on the eastern half of Federal coal lease D-034365, but does not indicate any mining on the western half. Presumably no development would take place for some time in the western half of this tract, which includes most of Sections 4 and 9, T.3N., R.93W. By the company's figures, this portion includes about 72,000,000 tons of strippable coal reserves.

A beneficial impact of the proposed plan would be the recovery of more coal than would be possible by underground mining. Using the generally accepted rates of 90 percent recovery for stripping and 50 percent by underground mining methods, and an original reserves figure of 93,000,000 short tons, an estimated 37,200,000 short tons would be produced that would have been lost by underground mining. Coal reserves of the region would be reduced by about 93,200,000 tons during the recovery of 83,700,000 tons from the proposed mine.

Water Resources

Ground water

As the mine would not extend below the top of the main zone of saturation there would be no discharge of ground water from this zone into the mine, and hence no lowering of the water table in the area. Runoff from the mined area would collect in the bottom of the pit. Downward leakage from the bottom of the pit might somewhat increase the amount of recharge to the main zone of saturation, but this increase is not expected to be large compared to normal rates of recharge. Water from the pit would be expected to be of similar quality to normal ground water in the area. Water percolating downward from the mine spoils would be expected to be of similar quality to the normal recharge from the undisturbed overburden.

Ground water would not be expected to accumulate in the mine spoils that are replaced over the mined-out part of the area; however the spoils that are placed in the valley of Streeter Creek would be at a lower altitude and could become saturated. If this happens, the spoils could become unstable and slide toward the valley of Good Spring Creek.

Surface water

The discussion presented in Chapter II on surface water involves the entire drainage system which would affect the lease area; this discussion is necessary to indicate the availability of water. Actual mining operation for the period 1976-1990 will be in the northeast quarter of the lease area according to the latest mining plan.

The area to be mined is drained on the west and north-central by Streeter Canyon and its tributaries. The central and east-central portion of the area is drained by an unnamed tributary of Good Spring Creek; the eastern and southern border areas drain directly to Good Spring Creek. Mining impacts would be confined to Streeter Canyon, those tributaries of Good Spring Creek which drain the central and east central portions of the area, and those areas which contribute directly to Good Spring Creek. Principal impacts to surface drainage would be the destruction of natural watercourses. Cuts which would be made while extracting the coal would be deeper than the bottom of the several channels, and it is unlikely that reclamation practices could reshape to original terrain. These waterways would be lost and new channels would have to be formed by natural or artificial means.

Due to the nature of the mine plan, any sediment that is generated from the mine spoils would be deposited in the mine pit. Rehabilitated areas would yield about 350 tons of sediment/year from the average 45 acres/year of disturbed land, and from land that has been revegetated but still is subject to accelerated erosion.

The coal haulage road to be constructed at the top of the west canyon wall of Good Spring Creek probably has the potential for contributing more sediment to Good Spring Creek than actual coal excavation. The road would start about eight-tenths mile south of the south edge of the mouth of Streeter Canyon. At the mouth of the canyon the road turns west up the

Canyon, to a point where a "U" turn can be made to continue downward at an allowable grade. Runoff that flows down fill embankments, down side slopes of cuts, and through borrow pits will cause movement of sediment. Considerable material will be moved during and immediately following construction, but will decrease as soil conditions stabilize. The 83 acres disturbed by the haul road would be expected to yield about 400 tons of sediment, and the 32 acres disturbed by the mine access road would be expected to yield about 160 tons annually.

Air Quality

Emissions

In order to determine potential changes in air quality due to operation of the proposed Colowyo Mine, emissions from all facets of the mining operation must be determined. These emissions must then be interpreted in terms of the ambient pollutant concentrations they produce in the air.

Five general sources of atmospheric emissions will be created by the proposed development at each mine. These sources may emit both fugitive dust and suspended particulates in the air, so a clear distinction should be made here. Suspended particulates are all kinds of particles, liquid or solids, that are small enough to act in the atmosphere in a manner analogous to a gas and not settle out rapidly due to gravity. Any disturbance of the earth's surface or the movement of material generates dust. If the dust is not prevented from becoming airborne at the source, it is called fugitive dust. Once in the air not all fugitive dust will be classed as suspended particulates. Some will be large enough to fall out rapidly near the source. These particles generally are not included in the suspended particle category.

The five sources of air pollutants at the mine are:

1. Mining. Three distinct phases of material handling during coal mining can be identified as major sources of fugitive dust: topsoil removal, storage, and replacement; overburden removal, storage, and redistribution; and coal removal and transport. Each produces a different degree and character of fugitive dust. Minor sources of fugitive dust are generated by blasting, scraping, loading, and dumping of materials.
2. Process. Mined coal must be processed to produce a product suitable for marketing. Coal conveying, sorting, crushing and storage are processes that produce fugitive dust. Control devices that collect and retain generated dust emit some particulate matter.
3. Vehicle Emissions. Particulates, hydrocarbons, carbon monoxide, nitrogen oxides, and sulfur oxides are emitted by mine vehicles, including scrapers, bulldozers, haulage trucks, light-duty trucks, and employee and service vehicles.
4. Roads. Unpaved roads are a source of fugitive dust from all traffic and from wind erosion. New emissions will result from increased traffic and wind erosion on unpaved mine access roads and roads within the mine boundaries.
5. Coal Fires. Coal fires in overburden piles and in exposed seams are a source of sulfur oxides, carbon monoxides, nitrogen oxides, and particulates.

Based on current regulations, the only significant pollutant generated by the first source, mining, would be suspended particulates which result from fugitive dust. Emissions estimates from materials handling in mining have been developed for topsoil, overburden, and coal separately, but with the same methodology. All the operations of removing the material from the ground, transport, piling, and redistribution have been combined into a single emission calculation using estimates developed from other studies of fugitive dust. Detailed calculations and references are given in Appendix D.

For mining, a fugitive dust emission rate of 0.0055 percent of the material handled has been calculated. This rate must be corrected for climate and control measures at the mine. Wet, snow-covered, and frozen ground limits dust generation. About 65 percent of the days in a year are expected to be so classified at the Colowyo Mine site. Using a calculational scheme described in Appendix D that takes into account the differing response of individual mining activities to climate, the corrected emission rate of fugitive dust is 0.0024 percent of material moved.

It is expected that during dry periods water will be applied to surfaces to inhibit the formation of fugitive dust by vehicles. Efficiencies will be poor, about 30 percent (Appendix D). The net effect will be to reduce emissions to a controlled rate of about 10 percent less than the uncontrolled rate given above.

Estimates of the quantities of material to be moved (Appendix D) were taken from the Draft Environmental Impact Statement Colowyo Mine (1974). In the years 1980-1990, an estimated 3,000,000 tons of coal will be mined per year, necessitating removal of 26,900,000 tons of overburden and 388,300 metric tons of topsoil each year. Emissions estimates for this quantity of materials handling is shown in Table GIII-1 as controlled and uncontrolled emissions.

These calculated estimates of emission rates are realistic approximations of the complex interaction of variables that affect dispersal of particulate material. Uncertainties (two standard deviations) are estimated to be on the order of a factor of two. All of the rates are given as yearly averages, even though it is recognized that all the activities are not continuous.

As an operation of mining, blasting has not been included in the previously described emission calculations. Overburden and coal are loosened for removal by blasting on a regularly scheduled daily basis. At a blast frequency of twice a day, weekdays only, each blast would involve half of the day's production, or about 6,000 tons of coal and 54,000 tons of overburden over a combined area of about an acre. Each blast normally takes place in a fraction of a minute. Unfortunately, no emissions factors are available for blasting, but the quantities of fugitive dust produced will be small compared to other mining activities simply because the blasting is so intermittent.

Process emissions of suspended particulates involve fugitive dust emitted from coal preparation for delivery and fine particulate matter emitted directly to the atmosphere from control device exhausts. Control devices are routinely used to collect and retain coal dust with 99 percent efficiency possible. Only one-half the dust generated is collected and passed to control devices so the controlled emission rate is 1 percent of one-half the uncontrolled rate, calculated in Appendix D to be 0.050 pounds (0.025 kilograms) of fugitive dust/metric ton of coal, or a loss of .0025 percent of the coal. Emission totals are given in Table GIII-1.

TABLE GIII-1

Colowyo Mine Air Pollutant Emissions

(Metric Tons per Year)*

Source	Air Pollutant	Uncontrolled		Controlled	
Mining Materials					
Handling:					
Topsoil	Suspended Particulates	5.6		5.0	
Overburden	Suspended Particulates	560		500	
Coal	Suspended Particulates	64		58	
Process	Suspended Particulates	136		68	
		Within Mine		Off Mine	
		Cars	Trucks	Cars	Trucks
Vehicle Exhaust	Suspended Particulates	0.083	0.066	0.79	4.3
	Hydrocarbons	1.06	0.19	9.5	12
	Carbon Monoxide	5.4	4.5	51	74
	Nitrogen Oxides	0.77	1.9	7.4	120
	Sulfur Oxides	0.020	0.13	0.18	8.7

* 1 metric ton = 1.1016 short tons

At the mine, there would be vehicle exhaust emissions from heavy diesel mine equipment, haulage trucks, and gasoline powered cars and trucks. Emissions from haulage trucks are calculated in Appendix D by considering the total yearly truck miles required to move coal to the processing facilities at the mine. Other mine diesel vehicles are considered to be a much smaller source than haulage trucks and have not been included.

Since emission factors for gasoline engines differ in distribution between pollutant but are of the same general magnitude/kilometer as those for diesel trucks, trucks cannot be considered alone. Emissions factors (Appendix D) show that cars emit about 80 percent more carbon monoxide than trucks but almost six times less nitrogen oxides. Car traffic would be expected to be significant at the mine and would include general employee traffic, supervisor, and service vehicles. Total kilometers have been estimated by assuming each employee travels a common distance within the mine site, approximately 4 kilometers (2.5 miles).

Table GIII-1 lists within-mine and off-mine emissions from vehicles separately. Because of the relatively large haulage distance to the railhead, the off-mine emissions dominate the totals. Automobile emissions were calculated by assuming one round trip from Craig per employee.

Another possible source of emissions related to mining would be the spontaneous or accidental ignition of coal fires in overburden piles and exposed coal seams. If a fire occurs, clouds of smoke containing suspended particulates, carbon monoxide, nitrogen oxides, sulfur oxides, hydrogen sulfide, and hydrocarbons could result. Estimates of frequency or quantity of emissions at any one mine cannot be made. However if a fire occurs the emissions might be substantial. McNay (1971) indicates that in the United States there were 270 burning coal refuse piles in 1968, 15 of which were in Colorado, over an area of about 130 acres; all were in older mined areas.

Impact on air quality

Particulates

Table GIII-1 lists five sources of suspended particulate from the mine. Vehicle emissions of particulate are usually not an air pollution problem and are obviously insignificant in comparison to mining operations. Overburden removal, because of the large tonnages involved, is the dominant mining source. It is assumed that the stripping is continuous during active mining. The variations in emission rate have been averaged out in the estimation of yearly emission rates, and in fact are the reason for not using shorter averaging times to specify emissions.

In order to assess the impact of the mine on the atmospheric environment, estimates must be made of the ambient total suspended particulate concentrations resulting from the emissions specified in Table GIII-1. To do this, an atmospheric diffusion model has been applied to the mine site. The effect of local emissions are considered over long periods (annual averages) and in terms of short duration exposures (daily concentrations) in the model used here. All of the emissions shown in Table GIII-1 have been added to represent a single source originating across the entire active mine site. This "area" source spread over an assumed disturbed area of .55 square kilometers/year (135 acres) appears suitable, considering the methods of calculating emissions and the wide variations in individual emission point characteristics during mining operations.

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The model is described in detail in Appendix D. It is a Gaussian plume model that integrates contributions from across the area for specified meteorological conditions. It is adapted to a specific site by adjusting the dispersion parameters and the meteorological input. The Colowyo Mine will be in a valley flow system where winds are often generated thermally to produce flow up the valley during the day and drainage down the valley at night. The mine site topography and the associated mine operations provide source variations for enhanced vertical mixing due to mechanical turbulence. To account for this, an initial mixing height of 10 meters (30 feet) has been assumed. This allows the pollutant to form a "puff" 10 meters (30 feet) deep before dispersing downwind.

In order to model worst case 24-hour concentrations, it was assumed that a wind speed of .77 mps (2 mph) persisted in one direction for eight hours during limited mixing conditions (thermally stable atmosphere). The remaining 16 hours of the day were assumed to contribute nothing to the 24-hour concentration. To account for slight variability in the wind direction over the eight-hour period, concentrations were smoothed over a 22.5° sector. A complete description of this process is provided in Appendix D.

Meteorological input into the annual average computations is somewhat more qualitative. Here again only one direction was considered: it was assumed that wind from the southwest occurred most frequently, about 20 percent of the time. This corresponds to the frequency of down-valley flow observed at Hayden and Craig weather stations. In addition it was determined from meteorological studies done near Craig and Hayden for the Yampa Project, that of this 20 percent, 5 percent is likely to occur during atmospheric conditions which allow substantial vertical mixing (thermally unstable atmosphere); 11 percent is likely to occur when vertical mixing is inhibited (thermally stable atmosphere), and the remainder or 4 percent when mixing is neither forced or repressed (thermally neutral atmosphere). A combination of these conditions weighted by their frequency of occurrence was used to provide annual average concentrations in the most probable wind direction. A more comprehensive description of this modeling scheme is provided in Appendix D.

The uncertainty in the calculated total suspended particulate concentrations can be approximated from the combined uncertainties of the inputs and the errors in the model itself. It is estimated that the modeled concentrations are correct within a factor of three. This uncertainty could be reduced only by much more detailed and preferably measured emissions and meteorological data.

Table GIII-2 is a compilation of Federal and State ambient air quality standards, existing background concentrations, and diffusion model predictions. For an annual average, the highest concentrations expected are those in the prevailing downwind direction during stable conditions. The model sums contributions during all existing meteorological situations, but for a source close to the ground, the suppressed vertical mixing and low wind speeds during an inversion are expected to dominate. Air flow during these times will often be downslope from the southwest. The largest predicted annual concentration is thus at the northeast edge of the mine site.

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TABLE GIII- 2

Air Quality in the Vicinity of the Colowyo Mine

Predicted Worst Case Concentrations ($\mu g/m^3$) from Sources at the Mine

Pollutant	Averaging Time	Ambient Air Quality Standards Federal			Existing Ambient Air Quality	Distance from Mine (km)	Maximum Predicted Concentrations	Predicted Plus Background Concentrations
		Pri	Sec	State				
Total Suspended Particulates	Annual	75	60	45	20	0.5	140	160
						2	33	53
	24 Hour	260	150	150	20	0.5	380	400
						2	160	180
Sulfur Dioxide	Annual	80	-	-	15	0.5	0.034	15
						2	0.0080	15
	24 Hour	365	-	15	15	0.5	0.093	15
						2	0.038	15
	3 Hour	-	1,300	-	15	0.5	0.28	15
						2	0.11	15
Carbon Monoxide	8 Hour	10,000	10,000	-	400	0.5	18	420
						2	7.6	410
	1 Hour	40,000	40,000	-	400	0.5	30	430
						2	13	410
Non Methane Hydrocarbons	3 Hour	160	160	-	50	0.5	2.1	52
						2	0.90	51
Nitrogen Oxides	Annual	100	100	-	15	0.5	0.60	16
						2	0.14	15

As shown in Table GIII-2 and Figure GIII-1, the decrease in concentration with distance would be rapid. Concentrations (including the background of 20 μg/m^3) will exceed the annual Federal secondary standard (60) out to 1.8 kilometers (1.1 miles) from the center of the disturbed area, and the Colorado Standard (45) for a distance of 2.5 kilometers (1.6 miles). Concentrations in other than the down-valley direction will be lower by at least 50 percent.

Meteorological circumstances resulting in the largest predicted 24-hour total suspended particulates concentrations are those which contributed most to the annual average, the existence of stable conditions. It has been assumed that stable conditions with a wind speed of one meter per second (2 mph) persist for at least eight hours. This could occur in any direction but is most likely to the northeast. The meteorological information available indicates that concentrations on the order of those in Table GIII-1 will occur between 10-30 days/year. Because the emissions are concentrated, the predicted concentrations shown in Table GIII-2 are relatively large. At 500 meters (0.3 miles), the highest concentration would exceed the Federal secondary and State standards by a factor of three. The decrease of concentration with distance is also shown in Figure GIII-1.

EPA non-degradation guidelines for Class II areas specify an allowable increase of 10 μg/m^3, annual average, and 30 μg/m^3, 24-hour average, for total suspended particulate ambient concentrations. These values will be exceeded in the prevailing downwind direction for distances of 4 km (2.5 miles), annual average, and 6 km (3.7 miles), 24-hour average.

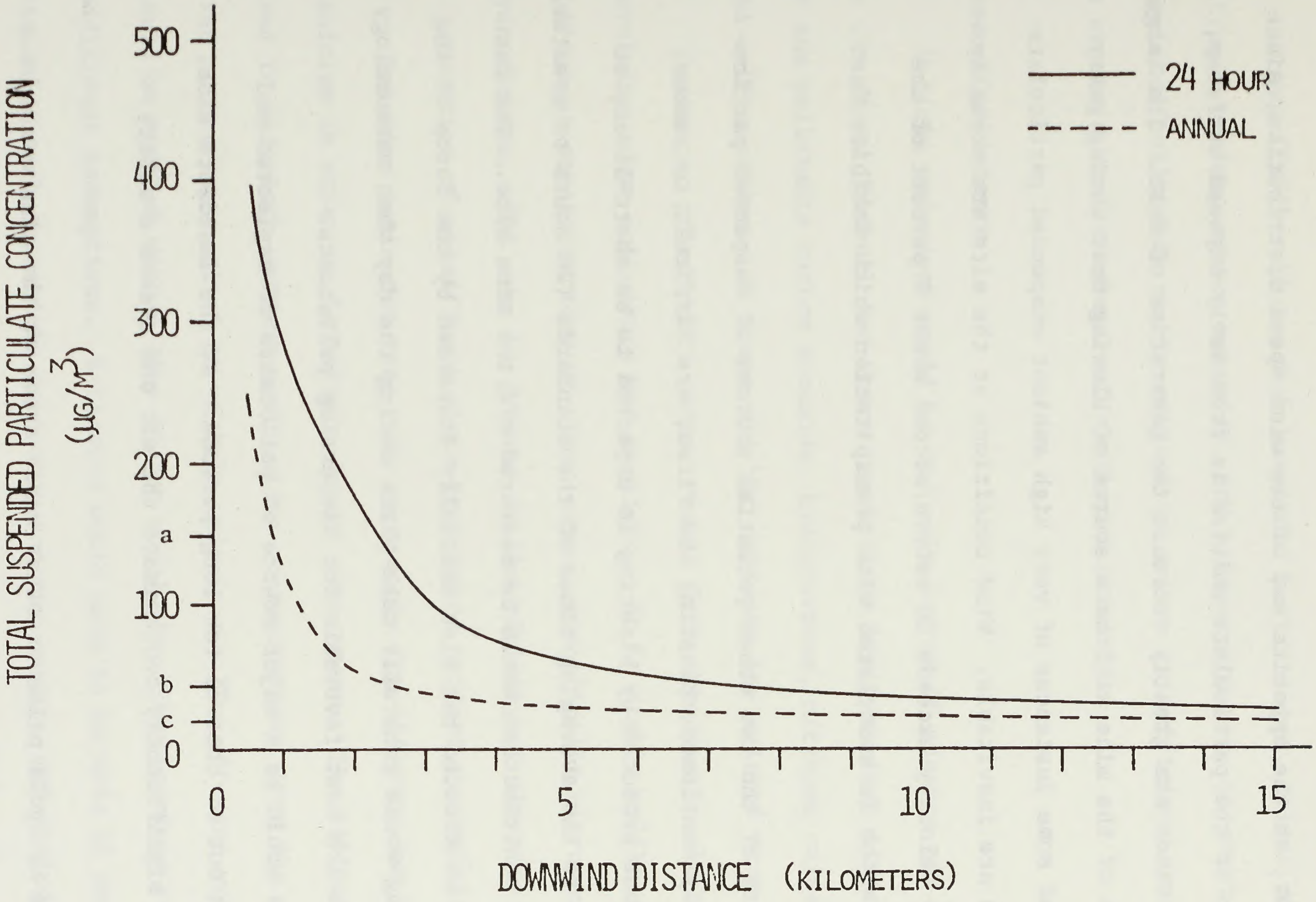

FIGURE GIII-1

Maximum down valley suspended particulate concentrations as a function of downwind distance from the Colowyo mine center. (a, 24-hour state standard; b, annual state standard; c, baseline concentration).

On a short-term basis, stability and low wind speeds characterize high concentration periods as predicted by the model using constant emission rates. However, on the opposite end of the wind speed distribution, since a good portion of the particulate emitted is from newly exposed surfaces, high velocity winds can greatly increase the generation of dust. The large disturbed area of the mine will be a source of blowing dust during gusty conditions, and some instances of very high ambient suspended particulate concentrations are inevitable. Wind conditions at the site are normally moderate. The velocity exceeds 10 meters/second about 3 percent of the time, part of which is associated with precipitation which inhibits dust generation.

The impacts of the two other potential sources of suspended particulates previously mentioned, blasting and fires, are difficult to assess. The cloud of dust produced by blasting is expected to be short-lived, at least compared to the averaging times of the standards (24 hours or greater) so that little contribution would be measured off the mine site. The dust produced would be created but also initially dispersed by the force of the blast. Blasting would generally take place during the day when meteorology characteristics are most favorable for dispersing pollutants.

Coal fires would be a major source of pollutants if neglected and allowed to burn out of control for long periods. At the immediate site, any fire could significantly contaminate the air and create a safety hazard.

Coal fires in spoil piles or other waste areas at the mine would be a major source of pollutants if allowed to spread to any large areas. Generally, available coal mixed in the overburden would be small and fires could be contained. However, if a low-grade seam or small pocket of coal is mixed in the overburden, a fire could ignite spontaneously.

McNay (1971) reports that suspended particulates, sulfur oxides, nitrogen oxides, carbon monoxide, and hydrocarbons or, in short, all the regulated pollutants can be emitted by a fire in sufficient concentrations to create a health hazard and aesthetic nuisance.

Gaseous pollutants

Vehicle emissions would be the only source of gaseous air pollutants at the mine. Federal and State regulations limit ambient air concentrations of the pollutants carbon monoxide, hydrocarbons, nitrogen oxides, oxidants, and sulfur oxides. Of these all but oxidants are emitted from vehicles.

Oxidants, principally ozone, result from atmospheric chemical reactions involving other pollutants and sunlight. It is highly unlikely that sufficient concentrations of other gases, specifically nitrogen oxides and hydrocarbons, will ever be present in the vicinity of the mine to result in a generation of significant above-background oxidant concentrations.

Emission estimates were made separately for off-mine and within mine vehicles in order to facilitate impact assessment. The diffusion model used to calculate ambient particulate concentrations from the mine as an area source was applied to vehicle emissions. The off-mine vehicle exhausts could be modeled with a line source model, but complications result in many additional assumptions. Estimates would have to be made of non-constant variables such as vehicle frequency and regularity, meteorological conditions over a large area, highway terrain effects, and contributions of other sources.

Results of modeling with mine vehicle exhausts are given in Table GIII-2. As in the particulate case, the predicted concentrations decrease rapidly with distance from the mine. Emissions from diesel and gasoline vehicles have been added together in the consideration of the mine as an area source. Applicable air quality standards and existing background concentrations are also listed in Table GIII-2.

The sulfur content in fuels is such that the impact of sulfur dioxide emissions is negligible for all averaging periods. There is essentially no deterioration of air quality from this pollutant. The other pollutants in the exhausts would add measurable concentrations to the background, within 2 kilometers (1.2 miles) of the mine, but only to a maximum of an 8 percent increase. No ambient air quality standard for SO_x would be threatened.

The within-mine vehicles are assumed in the model to be spread out over the entire disturbed area. In comparison, the off-mine vehicle emissions would occur along the road system. They constitute a source 50 times larger, as indicated in Table GIII-1. Ambient concentrations have not been modeled because of the lack of detailed input but general estimates can be made by using approximation techniques from EPA 1974. For carbon monoxide, at a distance of 100 meters (300 feet) from the road with a wind blowing along and slightly across the road, the maximum one-hour concentrations would be about 160 $\mu g/m^3$. This is a rough approximation, but it allows a comparison to Table GIII-2, where carbon monoxide concentrations of 30 $\mu g/m^3$ are predicted as resulting from within-mine vehicles. Compared to the standards, these levels are insignificant.

Table GIII-1 includes the emission estimates separately for automobile and mine haulage trucks. The most significant difference is in the contributions of nitrogen oxides; trucks are expected to emit about 95 percent of the total. Annual concentrations cannot be estimated by the approximation techniques used above but would also be expected to be insignificant.

Visibility

The addition of particulates into the atmosphere around the mine, either directly as suspended particulate emissions or indirectly as a result of chemical reactions of gaseous pollutants, would reduce the visibility in the area. Gaseous contribution is expected to be minimal. A calculation of the degree of degradation from suspended particulates depends on several parameters for which data are not available, the most important being size distribution of the particulates. Total suspended particulate concentrations however can be used to estimate visibility with the understanding that the relationship is not well defined, especially near a source of fugitive dust that contains a large fraction of relatively massive particles. Using the relation of visual range in kilometers equal to about 1800 divided by the average total suspended particulate concentration in $\mu g/m^3$ (Charlson 1969), the minimum visibility on an otherwise clear day would be on the order of 25 kilometers (15 miles). This was calculated using an average particulate concentration of 70 $\mu g/m^3$ as representative of the entire air mass affecting visibility during the worse case predicted 24-hour total suspended particulates shown in Table GIII-2. Visibility degradation of this order would be expected to occur with the same frequency as the maximum particulate concentrations, or about 10-30 days/average year. Presently the average visibility range over a year is estimated at 25 kilometers (15 miles). This estimate includes such factors as cloud cover, humidity, and background pollutant concentrations. Operation of the Colowyo Mine would reduce this estimate to no less than 20 kilometers (12 miles) on an annual basis.

Any incidents of coal fires in spoils could significantly reduce the above estimates of minimum visibility.

Living Components

Soils

Impacts on the soil by mining and associated activities would disturb about 856 acres by W. R. Grace during the period 1976 through 1990; see following tabulation.

Period	Acres Disturbed
1976-1980	415
1981-1985	201
1986-1990	240
1991-1995	211
1996-2000	218
2001-2005	214
Total	1499

Mining of the area would result in mixing together all existing soils within the mined area. The degree of soil redistribution is unknown and would vary from place to place. Soil characteristics would be changed with the microorganism composition, and other soil relationships to the changed environment that has developed over geologic time. About three million cubic yards of topsoil would be removed and replaced.

In addition to soil surface acreage that would be disturbed in the mined area during the periods mentioned above, overburden would be excavated during mining operations. This could result in bringing geologic material to the surface that might be toxic to plants and animals or retard plant growth. Investigations by BLM-EMRIA to the depth of about 200 feet shows little discernible toxic materials in the soil or overburden other than low-medium levels of sodium in places. The same study shows a low-moderate accumulation of sodium salts in the contact between living soil and underlying geologic materials, especially where the contact is with shale. Areal extent is unknown but is thought to be minor and should have little effect mixed with other topsoil materials. At the completion of mining the soil structure and its properties would be completely different from those presently existing.

The disturbances would result in fine-textured (clay) soil material from the shale strata and moderately coarse-textured (fine sand) soil material from the sandstone strata. The combination of these kinds of rocks exposed to weathering would produce a wide range of soil textures in varying thickness and arangements; the resulting soil material would be stony and difficult to work for seedbed preparation. Soil permeability and infiltration rates near the soil surface would be reduced by compaction when the spoil is shaped and topsoil replaced. This would increase runoff, thus adding to erosion and sedimentation. Wind action during dry periods would cause dust to be lifted into the atmosphere, reducing air quality and adding to soil loss. As all physical, chemical, and biological systems would be disrupted to an unknown degree, overall mining action would lower overall soil productivity.

Stockpiling topsoil would degrade the physical, chemical, and biological characteristics to an unknown degree, but undoubtedly to a lower quality than now exists. Existing soils would be covered and loss of production would occur on about 35 acres outside the mine area. The stockpile would be subject to erosion by wind and water, increasing atmospheric dust and sedimentation.

Drainage ditches outside and on the area to be mined would impact soils and vegetative cover. Assuming they are 16 feet wide and have a total length of about 4.5 miles, about nine acres would be affected by a loss of forage and an increase of flow into other drainages. The result would be increased soil loss and sedimentation downstream during periods of heavy runoff, as in early spring, or during high intensity rain storms. Loss of reparian vegetation and deep productive soils in Streeter Canyon would be permanent.

Mine facilities constructed outside the mined area would disturb or permanently remove about 50-60 acres of soil from production. Access corridors would be developed, such as access roads, haul roads, maintenance garages, and supply buildings with offices and loadout facilities. Sediment could be expected to be produced by machinery on the roads and in the mined area.

Other off-site soil impacts would result from increased population associated with mine employment. Population increase would generate increases on recreational uses, solid waste disposal, sewage disposal, schools, and other social facilities; these would cause unqualified soil impacts such as compaction, erosion, and sedimentation, an increase in water consumption, and a decrease in water quality.

Construction, mining equipment, off-road vehicles, etc., crossing undisturbed soil areas susceptible to compaction would impact soil permeability, water infiltration, and vegetative cover; this would increase erosion and sedimentation.

Terrestrial Flora

There would be two impacts on terrestrial vegetation due to the mining operation of W. R. Grace:

1. Total and partial destruction in the mined and otherwise disturbed areas,

2. Lateral impacts on surrounding areas.

During the 30 year life of the Colowyo mine, vegetation would be destroyed on approximately 1,500 acres. Vegetation would be affected as shown in the following table.

TABLE GIII-3

Vegetation Types, and Amount to be Disturbed by Activity (acres).

Activity	Vegetation Type Mountain shrub	 Sagebrush	 Total
Mining (1976-1980)	163	32	195
Mining (1981-1985)	89	112	201
Mining (1986-1990)	118	122	240
Mining (1991-2005)	154	489	643
Access road	0	32	32
Buildings and yard	0	25	25
Topsoil stockpiles (initial years)	0	16	16
Topsoil stockpiles (subsequent years)	7	12	19
Boxcut spoil stockpile	9	36	45
Haul Road	22	61	83
Total	562	937	1,499

The acreage figure for the haul road is calculated for the Taylor Creek tail loadout facility. If the Jubb Creek tail track or loop routes are utilized, which are alternatives to the proposed rail spur (see Figure GI-12), haul road construction would destroy an additional 29 and 31 acres of sagebrush, 12 and 10 acres of mountain shrub, and 7 and 2 acres of cropland respectively (see Figure GI-12).

Vegetation loss would begin with the construction of roads, drainage ditches, and surface facilities. Road and drainage ditch construction would alter the surface drainage pattern. Surface water that would normally

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run downhill might now be diverted to areas more convenient for discharge. This might cause some downslope areas to receive somewhat less moisture; this change in available moisture might cause some minor localized alterations in vegetative patterns. Sufficient information is not available to predict the extent of this impact.

The mining operation would produce the largest vegetative impact. Its first disturbance of vegetation would result from stockpiling topsoil and placing the boxcut spoils on undisturbed land; this would amount to approximately 80 acres during the 30-year mining period. The mature mining operation would leave approximately 45 acres totally disturbed at any given time before revegetation begins (not including the average permanently disturbed by roads and other surface facilities); total removal of vegetation from these acreages each year would have a secondary effect on surrounding vegetation. Once the vegetation is removed from the mining areas and is unavailable to herbivores, vegetation on surrounding areas may be subjected to increased utilization. Magnitude of this impact would depend on the importance of the area for wildlife forage, and the amount of overstocking of domestic livestock that takes place.

Overburden material from the initial cut would be cast into Streeter Canyon to a final proposed angle of 25 percent. This angle would increase the area of disturbance beyond that created by casting the material at the angle of repose, but would greatly increase reclamation potential of the spoil material, thereby lessening the overall impact of vegetative loss in Streeter Canyon. At the mouth the canyon is approximately 200 feet deep; it is estimated that grading the spoils to 25 percent would raise the floor of the canyon approximately 75 feet near the mouth (Figure GIII-2).

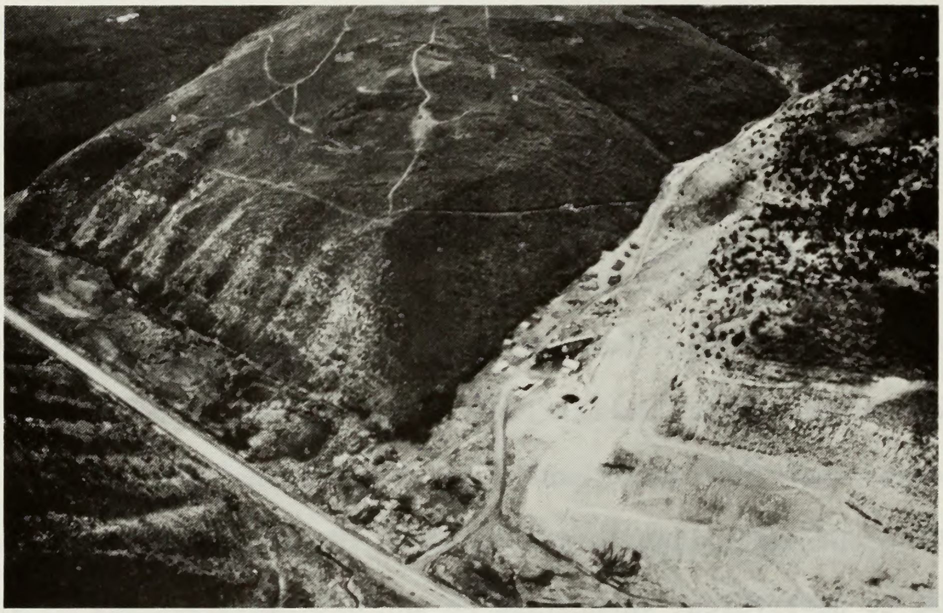

FIGURE GIII-2

Streeter Canyon, the north edge of W.R.Grace's Colowyo mine is shown. The hill to the left of the canyon would be mined, and original spoils cast into the canyon. Grading of the original spoil material to a 25 percent grade would raise the floor of the canyon approximately 75 feet near the mouth (current depth is about 200 feet).

Population increase associated with mine employment would remove an estimated 96 acres of vegetation by 1990. Vegetative types removed are indeterminable as location of population cannot be determined at this time. Increased recreational use by the new expanded population, especially off-road vehicle use, will affect additional vegetative types and acreages within the total study area.

Another impact to vegetation during the mining operation would be the effects of fugitive dust on plant life. It is difficult to predict the degree of impact produced by dust, but it would probably be minor. Dust would result from haul roads, blasting, overburden removal, and spoil shaping. Dust-covered plants might exhibit a decrease in vigor due to a lower photosynthetic rate. Vegetation covered by dust might be less palatable and possibly toxic to livestock and wildlife; however, this would likely constitute a very minor impact. Coal dust created by blasting and the loadout facility might also affect plant life; the degree of impact would depend on the cleanliness of the loadout facility.

A secondary impact from destruction of native vegetation would be the invasion of weedy species, such as Russian thistle (Salsola kali). They would compete with revegetation attempts, decreasing the success of permanent vegetation establishment.

At this point W. R. Grace has not developed a comprehensive seed mixture, pending the results of an extensive revegetation study on the lease site. If the current proposed mixture is not expanded, the resulting vegetation would have a very small degree of diversity. W. R. Grace is evaluating the use of alfalfa and legumes to reintroduce nitrogen into the soil system. In the past alfalfa has been utilized in reclamation efforts in the area, and has been found to dominate the revegetated area (Berg and Barrau 1973). In dominating, the alfalfa provides an excellent soil stabilizer and soil builder; however, it tends to create a vegetative stand with very little variety for a number of years, at least ten (Berg 1975). It is current theory that the stability of a plant community is a function of its species diversity, and that succession in an ecosystem is described as a progression toward higher diversity (Kormondy 1969). Diversity produces stability because there is less likelihood that any major shift or loss of any one component will adversely affect the system as a whole. It is evident from the increasing trend to pesticides in agricultural croplands that most monocultures do not produce self-sustaining stable vegetation. At this point it is difficult to predict the importance of this concept in analyzing the impact on vegetation at Colowyo mine, as the W. R. Grace reclamation program will not be finalized until ongoing research is complete. Also Stewart (1974) found that micro-organism activity increased on revegetated mine spoils in southeastern Montana as species diversity increased: micro-organism activity is very necessary for nutrient cycling and soil development processes.

Length of impact of native vegetation loss would depend upon the success of reclamation. The loss of the native vegetation might be quite long, and will depend mostly upon the rate and ability of native species to invade the area, and the extent to which trees and shrubs are transplanted from undisturbed areas to spoil areas. Some small areas, due to soil texture, toxicity, or other factors, might be impossible to revegetate, making the loss of vegetation a permanent impact. Since W. R. Grace's reclamation plan is not finalized and current methods, mainly the shaping of spoils to approximate original contours and replacing topsoil, have only been utilized for a few years, sufficient information is not available to predict the amount of time needed for native species invasion or the extent of areas unable to revegetate. In some years climatic conditions might be such that revegetation attempts would fail, extending the impacts of vegetative loss. The loss of existing soil geomorphologic conditions, and creation of different and inconsistent soil conditions might prove native vegetation difficult or impossible to re-establish.

Total destruction of native vegetation from an area would result in the following impacts on the vegetative ecosystem:

1. Loss of above and below ground primary productivity,
2. Loss of a diverse vegetation capable of withstanding climatic extremes and utilizing precipitation and sunlight throughout the growing season,
3. Loss of the present vegetative successional stage, and set-back to a very juvenile stage,
4. Loss of a natural seed source necessary for ecological succession and stability,
5. Loss of nutrient cycling systems that utilized the soil, plants, micro-organisms, and physical forces to cycle nutrients from the soil to forms usable by plants. These systems are essential for self-sustaining vegetation growth, and may be the greatest limiting factor to establishing self-sustaining plant ecosystems on mine soils,
6. Loss of soil stability and erosion prevention by roots and shoots of vegetation.

Young palatable vegetation produced by revegetation efforts would attract wildlife and livestock; grazing on young plants would inhibit early growth and revegetation of disturbed areas.

Terrestrial Fauna

Wild fauna

Development of the Colowyo Mine, as covered in this statement, would result in several adverse impacts on a variety of wildlife species.

Three major categories will be covered in this section: the mining operation, construction of support facilities, and reclamation activities. Each of these actions would impact the terrestrial fauna in its own particular way.

Mining operation

The major segments of a strip mining operation as related to terrestrial fauna, are: exploration, removal of vegetation, removal of topsoil, removal of overburden, and extraction of coal. The first three segments of this type of operation create the most significant impacts on wildlife.

During the exploration phase of the operation paths are cut through existing vegetation and pad locations are cleared. Drilling operations then take place. Most of exploration drilling has already been completed on the W. R. Grace site; however additional exploration is expected to take place within the lease west of the proposed mine area.

Destruction of vegetation creates impacts on fauna by reducing available nesting cover, escape cover, and food. The vegetative type being disturbed would determine the faunal species most affected (see Appendix D).

Noise resulting from drilling operation and movement of equipment would create what is expected to be a short-term impact on those faunal species in close proximity to the work area; noise will create a degree of anxiety in animals, the degree depending on the faunal species, closeness to the operation, and duration of it. Those animal species that are mobile enough, such as coyote, fox, deer, and most birds would likely leave the area, at least temporarily. Those species that cannot flee would probably retreat into their dens, under rocks, or into brush. Some animal deaths would be expected during this phase of the mining operation from vehicle-animal collisions as well as from den or nest destruction. Unplugged core sample holes would create a hazard to small mammals, amphibians, reptiles, and invertebrates, and could cause larger animals, such as deer, and elk, to step into them and break a leg.

Removal of all vegetation would be the first step in the process of getting to coal. Loss of this vegetation would result in a loss of food and cover needed by terrestrial fauna; the disruption of the mined portion of the ecosystem would be total. (See Appendix D for species affected by habitat type.)

A combination of vegetation loss and removal of productive topsoil would leave the mined area temporarily void of all animal life. This adverse impact would be exerted on all forms of terrestrial wildlife from soil mites to deer and elk.

Topsoil removed from initial cuts would be temporarily stockpiled west of the actual mine operation (see Figure GI-5). This stockpiled material would cover additional vegetation, primarily sagebrush, resulting in loss of habitat for sagebrush dwelling animals (see Appendix D).

Major impacts on wild animals of overburden and coal removal would be in the creation of a highwall and prolonging the amount of time the area would be disturbed. This highwall would create a potential hazard to animals as well as disrupting their normal movement and migration patterns.

Additional impacts on the existing ecosystem would result from dumping overburden into Streeter Canyon. As presently planned this overburden material is expected to completely cover the south slope of the canyon as well as the entire canyon bottom; it will also cover the lower 75 feet of the north slope of the canyon. This would result in the loss of all this area for wildlife use until the revegetation program has been completed; even then the area would never return to its natural or presently existing status. Some direct loss of life would result from the partial filling of Streeter Canyon; nesting birds, rodents, amphibians, reptiles, and maybe even deer would be lost.

Riparian vegetation would be lost by the dumping of spoils into Streeter Canyon as well as the projected box cut west of the fill area (see Figure GI-5).

Total loss of wildlife habitat resulting from the mining operation would be in a constant state of progression across the lease area from north to south. Table GIII-3 indicates the proposed acreages that would be stripped between 1976-2005. An estimated total of about 1,279 acres would be mined by this operation.

There would be a one-year time lag in the mature operation, from topsoil removal to beginning of revegetation efforts. This would mean that approximately 45 acres of land would be unavailable to all wildlife as a direct result of mining at any given time during the life of this operation.

All previously mined areas would be in some stage of reclamation, therefore providing some wildlife habitat value.

Less mobile faunal species such as many reptiles, invertebrates, and small mammals would be unable to flee and would be destroyed. The larger and more mobile species such as deer, elk, coyote, grouse, and other birds would be able to move onto adjacent lands. These displaced animals would probably be moving into a less suitable location, or an area that is already supporting populations that are in balance with their habitat. All or most of the displaced animals would probably be eventually lost as the total population begins to adjust to the carrying capacity of each species' habitat, and as the interspecific and intraspecific intolerances are resolved. Animals that have been displaced would be in unfamiliar territories, and studies have indicated that most dislocated wildlife species are much more vulnerable to the effects of predation than in their home ranges. Probability of food and cover shortages as well as the spread of disease and parasites would also be increased as population densities become greater.

The entire 1,279 acres (see Table GIII-3) that is proposed to be mined by 2005 provides habitat for deer and elk. Using the same population estimates that were presented in the Existing Environment section, habitat capable of supporting approximately 50 deer and 25 elk would be destroyed. This loss would represent a permanent reduction in the habitat's ability to sustain existing herd size and composition unless reclamation programs could restore the mined areas to an equal or greater carrying capacity than that which is presently available.

Impacts on bear and cougar would be expected to be insignificant because of the low population densities of these two species within the region and the low indices of use they have exhibited for the subject area. Some adjacent lands would probably also become unsuited for these species because of the close proximity of human activity.

The most significant impact on the rabbits and hares would be loss of food and escape cover during the mining operation; populations would decline in the limited area that has been denuded of vegetation. Potential impacts to bats are not known although it is expected that these species would relocate.

In all probability, increase in human activity and noise associated with the mining operations would cause some wildlife species such as coyotes, fox, and many birds to leave the working area prior to actual habitat destruction. The probability of an increase in vehicle-animal collisions would also be associated with the increase in human activity.

Access has been limited since the area was acquired by the W. R. Grace Company; additional restrictions would also be expected, thus reducing hunting pressure on big and small game species. This would allow hunting by authorized employees only. This practice could eventually result in improper population management of huntable species such as deer, elk, and rabbits.

Additional habitat destruction might result from business and recreational use of vehicles, off the roads, on lands adjacent to the proposed mined areas. This would cause a related reduction in the number of certain species of wildlife such as deer, rodents, and other herbivorous species, as carrying capacity is reduced and nests and dens are destroyed.

Water quality would not be expected to be affected to any major degree by the mining operations; however water quantity would be affected by the loss in availability of portions of Streeter Creek, and eventual loss of some stock tanks as the mining operation continues. This impact would result in removing these areas from potential use by waterfowl, amphibians, insects, and many mammals; by doing so it would reduce the area's ability to sustain a balanced ecosystem similar to the one that presently exists.

Loss of sagebrush would preclude the mine site's use by sage grouse; this loss of habitat could result in the displacement of about 60 birds. Colowyo mine is known to be used by sage grouse for brood-rearing and probably for nesting, although no strutting grounds have been located in close proximity to the mine site. Blue grouse nesting areas would also be lost when aspen stands are destroyed.

The area's carrying capacity for mourning dove would be reduced as a result of the loss of vegetation, at least until revegetation work is completed.

A reduction in raptor nesting would possibly result from increase in human activity and potential loss of adequate nesting sites. The red-winged hawk, Swainsons hawk, and the American kestrels are potential nesters in the area, although no nests have been located at this time.

Because of a lack of knowledge of the amphibian and reptile species present, little can be said as to the impacts on this segment of the terrestrial fauna; most species of this group are not mobile enough to escape destruction from mining equipment. Some species, such as rattlesnakes, would be killed by miners and recreationists in and around actual mined areas.

Little is known of the species composition of terrestrial invertebrates; therefore nothing specific can be said about the impacts on them. Numbers would certainly decline in the mined areas until rehabilitation begins but to what extent is uncertain.

Support facilities

This category would include roads, buildings, and powerlines. Two types of roads are proposed for the mine: an access road and haul roads. The access road would extend approximately four and one-fourth miles from the mine office south to the maintenance facilities (see Figure GI-2). This road will be about 75 feet wide and will be used for employee access and maintenance vehicles. Two major impacts would be created by this road: vegetation would be cleared from the roadway which would result in a loss of forage, nesting cover, and escape cover. The terrestrial wildlife most affected would be those species associated with sagebrush vegetation type (see Appendix D for an indication of the species concerned). Approximately 32 acres of sagebrush habitat would be destroyed by this road. The second major impact would be increased potential of vehicle-animal collisions; this includes big game as well as small non-game species.

The haul road, as proposed, would be constructed along the east side of the mine; during the early phase of mine operation it would be used to get the coal from the work area to Colorado State Highway 13. After the railroad spur is put into operation, haulage would be moved to loading facilities as shown in Figure GI-12. This road would result in a loss of some habitat values (see Figure GI-2).

Direct loss of vegetation, nests, and dens would result from the cutting of the roadway. Additional vegetation would be lost due to being covered up by cut material that is pushed to the side of the road (see Figure GI-11). The road will be 75 feet wide and the area covered by the fill would vary depending on the amount of cut material and the degree of slope. Approximately 83 acres of wildlife habitat would be destroyed by this road (see Table GIII-3).

The maintenance yard and office grounds would occupy about 25 acres, primarily in sagebrush vegetation type. All areas used for these structures would be considered as a permanent loss to wildlife, with the possible exception of some house mice, English sparrows, and other rodents and birds that choose to live in and around man's dwellings.

A 69-kv powerline would be installed from an existing line that lies east of the mine area (see Figure GI-12). Approximately 13,800 linear feet of new powerlines have been proposed. The average distance between power poles is normally 500 feet although this varies dependent upon wire size and terrain. Figuring 500 feet between poles, 28 poles would be installed; approximately 50 square feet of vegetation would have to be cleared at each pole site to make a pad for pole erection and line construction. This would total 1,400 square feet of destroyed habitat in addition to maintenance roads that will have to be constructed. Most of these clearings would be in oak serviceberry vegetation type and would impact those species associated with mountain shrub type (see Appendix D).

Approximately 245 acres will be permanently removed from existing wildlife use as a result of all mine-related activities, including the off-site areas needed to accommodate the increase in human population resulting from the mine's employment.

Reclamation

It is W. R. Grace's current land-use plan to return their mined land to the existing usage; this would have a favorable impact on the present faunal species composition by reestablishing a similar ecoysytem. The precise methodology that W. R. Grace plans to use has not as yet been determined and therefore it is impossible to evaluate their impacts on terrestrial fauna. All that is known is that W. R. Grace wants to return native brush and tree species to the disturbed areas in the same approximate areas and densities that they now occupy.

Rodent numbers would be expected to respond rapidly to revegetation programs; abnormally high rodent population would be expected as the tender and succulent vegetation becomes available to them. Seed-eating birds and rodents would be expected to cause some losses in planted seeds, thus reducing the revegetation program's optimum potential. Species composition and densities of these rodents would vary, dependent on the successional stage of reclamation and the plant species used in revegetation. It is unlikely that the species composition would return to its exact pre-mined status. High rodent numbers would be expected to attract and sustain a larger than normal number of predators, mainly coyotes, fox, snakes, and raptors.

According to the W. R. Grace modified reclamation plan, "All reclaimed areas will be adequately fenced to prevent wildlife or domestic grazing until vegetation is sufficiently established." This is interpreted to mean that a big game-proof fence would be installed around all revegetated areas, for at least two growing seasons and probably longer to exclude all such areas from big game use. This is needed to allow the vegetation to become established; however, it would also act as a barrier to normal animal movement, and direct loss of animal life might result from entanglement in these fences.

Jackrabbit populations would be expected to make a rapid recovery in areas where herbaceous cover has become successfully established. Cottontails would not be expected to respond to revegetation efforts to a significant degree until brush would have been replaced.

Mourning doves prefer to feed in weedy fields; if the revegetated areas are invaded by seed-producing weeds, overall dove use would increase.

The degree of invertebrate recovery from the impacts of the mining operation would depend entirely on the vegetal species composition and success of the revegetation program.

Domestic fauna

All livestock would be moved out of the proposed mined areas prior to the beginning of actual work; therefore no livestock would be expected to be destroyed by these activities.

Approximately 180 acres would be totally lost to livestock at any given time during the mining operation. The resulting loss of AUMs would vary from 26-33 depending on the vegetation type that is being cleared. All previously mined areas would be in some stage of reclamation. All revegetated areas would be fenced to prohibit livestock grazing for a period of at least two growing seasons. Fences along roads and around the areas being mined or reclaimed might adversely affect livestock movement to water, salt blocks, etc.

It is W. R. Grace's current land-use plan to return their mined land to the same usage as now exists; the precise methodology that they plan to use has not been determined; therefore it is not possible to evaluate their impacts on livestock. All that is known is that W. R. Grace wants to return native brush and tree species into disturbed areas in the same approximate areas and densities that they now occupy.

Table GIII-4 indicates that approximately 1,500 acres representing 236 AUMs would be altered during the 29-year life of this mine. It is expected, because a variety of grasses would be seeded along with shrubs and trees, that the overall carrying capacity of the area for livestock would be increased at the end of the mining operation. The amount of increase cannot be estimated at this time because of the lack of information concerning revegetation plans.

TABLE GIII-4

Carrying Capacities and Loss of Animal Unit Months by Vegetation Types from 1976 to 2005

Vegetation Type	Carrying Capacity in Acres/AUM	Acres Disturbed	Total AUM's Lost
Mt. Shrub	5.50	562	102
Sagebrush	7.00	937	134
Total		1,499	236

Aquatic Biology

Proposed mining activity would impact the aquatic ecosystem in Good Spring Creek. One adverse impact would result from construction of haul roads and access roads in the area. Surface runoff from road construction areas would increase the sediment load in Good Spring Creek if road debris were allowed to reach the creek. This increase would adversely impact the aquatic community by degradation of critical habitat areas, as well as through a loss of individual organisms from the suffocating and abrasive effects of increased siltation. These impacts would be particularly noticeable within the benthic fauna and periphyton populations.

The rate of siltation in Axial Basin Reservoir would be increased by more rapid sedimentation in Good Spring Creek. Depending on the increase in sediment loading, the aquatic habitat in Axial Basin Reservoir could be eliminated in the space of several years. According to the Colorado Division of Wildlife (1972), the reservoir has an average depth of only ten feet; a significant sedimentation increase would rapidly bury the existing aquatic habitat.

Cultural Components

Archeological Resources

Total projected acreage disturbance for the Colowyo mine by 1980 is 415 acres, by 1985 - 201 acres, and by 1990 - 240 acres, and 643 acres by 2005. This acreage disturbance could impact presently unknown subsurface cultural resources. Employment projections for the Colowyo Mine will remain constant from 1980 through 1990 at a total employment of 244. This would result in a greater exposure of known cultural resources to potential pothunting and vandalism than presently occurs. Impacts to known sites are shown in Table GIII-5. As per Dr. Lischka's intensive survey, none of the sites are of National Register significance.

TABLE GIII-5

Impacts to Cultural Resources

Site No. (See Figure GII-14)	Nature of Probable Impact			
	Subject to Direct Physical Displacement			Vandalism
	Mining	Roads & R/W's	Topsoil Storage	
1				X (on lease but outside proposed action area)
2		X		X
3				X (off the lease)
4	X			X (to be mined about year 2000)
5 (Archeological)		X	X	X
6 (Historical)		X	X	X

Historical Resources

Impacts to historical resources due to acreage disturbance and due to increased vandalism and pothunting would occur as shown above under Archeological Resources, Table GIII-5. As per the intensive cultural resource survey, none of the sites are of National Register significance.

Aesthetics

The areas to receive the greatest impacts would be those where proposed actions do not borrow form, line, color, and texture (visual dominance elements) from the characteristic landscape. In other words when the dominance elements inherent in the proposal do not complement those of the landscape into which the proposal is to be placed, it will not "fit" and is therefore labeled a minus deviation.

By referencing landscape visibility maps (Chapter II) and proposed action areas (Chapter I), the areas having greatest potential for adverse impact may be identified.

In terms of distance the most sensitive areas are foreground visual units, and the least sensitive are background units; this can be read directly from landscape visibility maps.

When landscape visual units are viewed obliquely, their portion of the total picture plane is relatively small. When viewed more directly (at a greater viewing angle) the picture plane size increases in scale and so do the minus deviations that would occur there. This can also be read from the landscape visibility map by referring to: (1) contour alinement (aspect) and (2) contour spacing (slope), both with respect to the viewshed sequence that provides visual access to the particular landscape visibility unit in question.

A greater potential for adverse impacts also occurs when landscape visual units may be viewed from more than one road segment (viewshed sequence), are viewed for a greater distance along those viewshed sequences and lie at different distances when visible from more than one viewshed sequence. This also can be read directly from landscape visibility maps.

The largest scale elements in the landscapes containing the proposed action would be the coal stripping area. However most of the minus deviations resulting from that operation at the Colowyo mine would result from roads and rights-of-way that are attendant to the proposed action itself because they cover a larger geographic area and are relatively permanent fixtures. They also occupy landscape visual units that are relatively more visible than those on the Colowyo mine itself.

Proposed dumping of mine spoils into Streeter Canyon would result in minus deviations of form, line, color, and texture, as their initial pattern does not borrow these elements from the characteristic landscape. Within the first three years of the stripping operation, a repetitious pattern of sharply angular ridges foreign to this otherwise undulating, steep, and irregular landscape would be visible as foreground from viewshed sequence MN (Figure GII-17). Strong line dominance of the initial highway haulage road would also be a minus deviation during the same time frame. Intermediate crushing and loadout facilities would occupy the foreground at MN for the first three years, and would have form, line, and color that contrasts with the characteristic landscape.

About two years after the mine begins, scheduled reclamation of spoils in Streeter Canyon would reduce the minus deviations resulting from sharply angular spoil piles. However the permanent haul road would remain visible in both foreground and middleground to travelers on viewshed sequence MN.

Additional minus deviations in the foreground would result from extension of the east haul road across the drainage visible to the west of viewshed sequence KL. This is scheduled during the eighth year of mining. This section of road would be a large fill that would initially borrow no form, line, color, nor texture from the characteristic landscape.

Though most of the actual stripping operations would not be visible, significant portions would produce similar minus deviations in the middleground, as viewed from viewshed sequences JK north, KL, LO south, and MN.

A significant portion of 1979-1989 stripping operations would be visible from viewshed sequences JK and KL. Seven cross-sections were drawn of views from these sequences to determine the extent of the view. The viewing angle to these landscape visual units is small, so the element of line will be a strong component of the proposed actions due to silhouettes that would result from proposals in this area. However the actual picture plane of the ground surface occupies a small portion of the total visible landscape. Drag lines, spoil piles, and the haul road would be strong minus deviations because their lines do not borrow from the characteristic landscape, and their form would contrast with the landscape also.

The east main haul road route would traverse the crest of steeply sloping hillsides, at approximately the 6,800-foot contour that lies immediately adjacent to Good Spring Creek. The main haul road would have a 75-foot cut on the uphill side. (The top of this cut would be the shoulder for the "F"-seam haul road). In addition a high berm spoil bench would be built on the fill-slope of the main haul road to obscure views of the mine. Barren slopes of both cut and fill banks of the main haul road would be strongly form, color, and texture-dominant minus deviations from the characteristic landscape. Because of the viewing angle at viewshed sequence JK, a very large spoil berm would be necessary to hide the 75-foot cut as well as the mine. Resulting fills would extend down the slopes toward Good Spring Creek, creating an exceptionally large form, color, and texture-dominant minus deviation.

Stripping operations from the first four years of operation, and portions of the main haul road, would also be visible from viewshed sequence MN. Southbound travelers on viewshed sequence LO would be able to view the main haul road directly in line with Highway 13, in an area where operations would be occurring from the eighth year through the eleventh year of mining, beyond which it would no longer be visible. Mining operations would also be visible in the same landscape visual unit during this time.

Southbound travelers on viewshed sequence RS would be able to view only the eastern portion of the topsoil and spoil areas that lie west of the initial boxcut. Though these would be distant middleground views, strong form and color-dominance of these stockpiles would result in minus deviations from the characteristic landscape.

A substation proposed adjacent to viewshed sequence KL would result in form, line, and color dominance intrusive upon the characteristic landscape. The 69-kv distribution line, color and strongly line-dominant, would be a minus deviation. Due to its proximity to sequence KL, it would occupy a large part of the foreground picture plane. Portions of the transmission line would be less visible in the middleground as viewed from viewshed sequence KL; most of the powerline would not be visible at all.

Secondary proposals would also impact the aesthetic environment of the area near Axial (Figure GII-18). The proposed mine office area would be a large scale element of the foreground picture plane at viewshed sequence QV and to a lesser degree at sequence PQ. Form and color-dominance of these structures might produce minus deviations, even though other buildings already would lie in the general area. They would be also visible to a lesser degree in the middleground landscape viewed from viewshed sequence PQ.

The proposed access road would traverse several middleground visual units (Figure GII-18). Visible from as many as seven different viewshed sequences, this road would result in sizeable cuts and fills as it ascends a very prominent hillside. Strong form and color dominance of these road construction scars would result in significant minus deviations from the characteristic landscape. Proposed switchback construction necessary on this steep hillside would increase the scale of these impacts.

The proposed coal haul road would partially coincide with the access road to loadout facilities near the top of the hill (see Figure GI-12). The loadout facilities above Taylor Creek Canyon would be visible from several viewshed sequences (see Figure GII-18). The conveyor down to the actual rail loading site would be visible as middleground from County Roads 17, 32 and 51. Strong line and color dominance of these features would adversely impact the visual landscape.

If vegetation that is cleared during road construction, or in connection with the mining operation itself, is scattered adjacent to the disturbed area or piled and burned it would produce an aesthetically unconforming landscape of forest litter. Disposal of refuse and waste from the mining operation could also produce an undesirable landscape of litter if it is not visually screened and properly maintained.

Road, blasting, coal dust, and exhaust emissions would create short-lived landscapes foreign to the environment that are also minus deviations.

The overall aesthetic experience at the Colowyo mine area would also be adversely impacted. Descriptions of mood-atmosphere reactions are subjective and vary from one person to another. The natural character of the proposed action area can unquestionably kindle feelings of isolation, solitude or respect for nature. The proposed action might both adversely and beneficially impact this inspirational quality, either by disturbing the landscape's natural integrity (adversely) or by revealing the complexity and massiveness of nature's grandeur (beneficially).

Aesthetic impacts in terms of numbers viewing visible areas (i.e. visual sensitivity) would increase commensurately with traffic volume increases. Current average annual increases in average daily traffic on Colorado Highway 13 adjacent to the mine site are 14.2 percent.

Recreation

Surface mine operations on Federal lease D-034365 would directly remove big game species from the immediate area of operations on the lease area. These species would also be directly displaced on adjacent areas due to attendant facility and linear right-of-way construction, which would diminish big-game viewing opportunities.

Runoff from unstabilized areas on adjacent access and haul roads would result in increased downstream sedimentation. This change could adversely impact the recreation resource at Axial Basin reservoir by diminishing its capability to attract and support fishing use, though this impact would be expected to be slight.

Stripping operations, road and right-of-way construction, and other attendant mine facility construction that occurs on steep slopes could result in dumping overburden and rocks down steep hillsides. Where this action occurs adjacent to Colorado 13, it would create safety hazards. The haul road proposed to run immediately below the easternmost exposure of the "F" coal seam would cause such impacts. Overburden blasting at the proposed mine area might also dislodge rocks on steep hillsides above Colorado

Highway 13, thereby creating additional safety hazards for recreation users traveling thereon.

Unknown archeological sites might be destroyed by mining operations, and therefore lose their inherent capability to attract and accommodate recreation use irrespective of existing public access deficiencies. This loss could occur through actual destruction of the resource by mining itself, either by direct removal, by off-site influences such as seismic damage from blasting, or through vandalism and pot hunting by mine employees. Mine employees would number 244 at full-scale production; this level would be reached in 1979.

Proposed initial highway haulage will create driving hazards for sightseers and tourists; these hazards will occur in the form of heavier truck traffic, rocks thrown from between dual wheels, and small pieces of coal falling from traveling trucks.

Successful revegetation efforts on mined-over areas might result in beneficial impacts to wildlife viewing opportunities by attracting more animals than are now present, though management decisions to fence reclaimed areas would preclude these benefits.

Additional roads, trails, and stripped areas can beneficially impact the area's capability to attract and support off-road-vehicle (ORV) use; this would increase both snowmobiling and trail bike use potential. Success in surface mine reclamation would also help determine ORV capabilities as potential for sustaining ORV use is determined largely by surface soil quality. Management decisions at Colowyo mine that either allow or deny recreational access prior to reclamation would determine whether such benefits will be realized.

Beneficial impacts would also include increases in rockhounding capabilities as overburden removal would expose interesting and collectible rocks and fossils.

Greater capabilities for geologic and industrial interpretation would be other beneficial impacts of the proposed action. Though public access does not now exist, Mt. Streeter as well as other viewpoints (see Aesthetics section) offer potential for informing the visiting public of physical and economic conditions conducive to strip mine development at Colowyo mine area. This could be accomplished by sign construction and interpretive-educational brochure development, as well as by guided tours. Capabilities to attract this type of recreation use would also be enhanced by the relative uniqueness of this combination strip and open pit mine proposal.

Social Environment

Table GIII-6 presents the population impact by county and community of the development of the Colowyo mine; it also indicates expected new school enrollment by county. These data were generated by the gravity-employment multiplier model described in Chapter IV of the Regional Analysis (Future Social Environment Without the Proposed Action). They represent incremental increases over and above the base scenario presented in the same section of the Regional Analysis.

Requirements for new social support facilities including housing, health care, education, water and sewage treatment, fire protection, and law enforcement are functions of increases in population. Table GIII-6 indicates that development of the Colowyo mine would induce a relatively small increase in population; therefore, impacts on existing social support facilities would be relatively small. It is the cumulative impact of several new developments that generates significant new requirements for social support facilities; these requirements are addressed in depth in Chapter IV of the Regional Analysis.

There have been no expressions of local attitudes specifically oriented toward the development of the Colowyo mine. Rather attitudes are directed toward the subject of regional and community growth in general (and are therefore examined in the Regional Analysis).

Table GIII-6 indicates an induced population of 958 people by 1990. An estimated 96 acres for additional residences and community facilities would be needed to accommodate this growth.

For an extensive analysis of the regional impacts, mitigations, and unavoidable adverse effects to which the development of the Colowyo mine would contribute, refer to the appropriate chapters of the Regional Analysis.

TABLE GIII-6

Population Impact of Colowyo Mine Development

	1980	1985	1990
Direct Employment at Colowyo	244	244	244
New Population			
Moffat County total	561	600	613
Craig	561	600	613
Rio Blanco County total	252	263	271
Meeker	252	263	271
Routt County total	69	72	74
Hayden	69	72	74
Total	882	935	958
New School Enrollment			
Moffat County	103	117	129
Rio Blanco County	48	51	56
Routt County	13	14	15
Total	164	182	200

Economic Conditions

Table GIII-7 presents the economic impact of development of Colowyo mine in terms of employment and earnings. These data were generated by the gravity-employment multiplier model described in the Regional Analysis (Future Economic Environment Without the Proposed Action). These data represent the incremental impact over and above the base scenario described in the same section. Note that in each of the benchmark years, the greatest induced employment and earnings impacts from the Colowyo mine development would fall in Moffat County.

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No adverse economic impacts would be expected to be associated with the development of Colowyo mine because both the direct and induced employment and earnings are relatively small compared to the economic base of the region.

TABLE GIII-7

Economic Impact of Colowyo Mine Development

	1980	1985	1990
Direct Employment at Colowyo	244	244	244
Induced Employment			
Moffat County	121	132	133
Rio Blanco County	53	56	58
Routt County	14	14	14
Total	188	202	205
Direct Earnings	5461	6102	6844
Induced Earnings			
Moffat County	1219	1500	1741
Rio Blanco County	534	632	745
Routt County	144	157	177
Total	1897	2289	2663

Note: Earnings data in thousands of 1974 constant dollars.

Transportation Networks

Highways

W. R. Grace's Colowyo mine at Axial, Colorado, would be producing coal for a period of about two years before a planned rail line for moving coal would be completed. During this period, it is planned that coal will be moved in 30-ton capacity trucks between the mine site and a tipple point south of Craig, Colorado via Colorado Highway 13. The mine output is expected to be 620,000 tons in 1976 and 900,000 tons in 1977. Using a 240 day/year hauling schedule, this amounts to approximately 172 loaded truck trips/day from July 1 in 1976 to the end of the year, and 125 loaded truck trips/day in 1977. Since only 12 trucks would be used for this hauling task, W. R. Grace might wish to keep the number of truck trips to 125/day in 1976. If this would be done, it would necessitate hauling 165 days, instead of 120 days, in the latter half of 1976.

The Colorado Highway Department has stated that with the severe weather conditions to which highways such as Colorado 13 are subjected each year, heavy truck traffic such as that described above could be very detrimental to the integrity of the road surface within a comparatively short period of time. Given the right combination of moisture and frost conditions in the Spring, heavy coal-truck traffic could cause large sections of a highway such as Colorado 13 to go to pieces. Such an impact would be compounded by the increasing general and recreational use of this stretch of Colorado 13 (W. R. Grace site specific analysis, Chapter II). A breakdown in the road surface, caused by an increase in coal truck traffic, would have an extremely detrimental effect on other traffic moving over this section of Colorado 13.

In addition, the three bridges on Colorado 13 located south of Hamilton are restricted weight bridges. The Colorado State Highway Department has no plans or funds to upgrade these three bridges or the unimproved stretch of roadway of Colorado 13 south of Hamilton, Colorado, to accommodate the increased coal truck traffic.

There would be some danger of mining activities impinging upon traffic on Colorado 13, since some of these activities are quite near (and above) the road. Some protective features must be installed and mine operational procedures instituted to insure traffic safety. Noise levels would undoubtedly increase due to additional diesel truck coal hauling over Colorado 13. This increase has not been quantified and thus no judgment can be made on its significance (see Construction Equipment Sound Levels in Table GIII-8).

Railroads

W. R. Grace has decided that, with a proposed output of three million tons of coal/year by 1980, a rail line from their Axial mine to a junction with a planned D&RGW railroad spur (to a Colorado-Ute plant site) south of Craig, Colorado, would be necessary. However, this is not part of the proposed action for the Colowyo mine and is addressed in a separate analysis in this document.

TABLE GIII-8

Typical Construction Equipment Sound Levels

(Decibels "A" - Weighted Sound Levels)

Equipment	Sound Level -dB(A)
Rock Drill @ 100 feet	92
Scraper - Loader @ operator station	117
Compressor @ 20 feet	92
Bulldozer @ operator station	103.3
Compactor @ operator station	116
Front Loader @ operator station	93
Grader @ operator station	88.7
Diesel Truck, 40 mph @ 50 feet	84

SOURCES: Ohio Environmental Health Association, 1973 and Wayshak, 1973.

Airlines

The only real effect that the initiation of W. R. Grace mining and railroad operations would have is increased passenger loads into the Yampa Valley Airport at Hayden. Since this airport is now undergoing a ten million dollar improvement operation, any increases due to the W. R. Grace mining plan approval should be easily absorbed by the improved airport facility. Some increased use of the limited closer facilities at Craig might also occur.

Chapter IV
Mitigating Measures

THIS CHAPTER PRESENTS MEASURES THAT WOULD LESSEN OR ELIMINATE THE ADVERSE IMPACTS OF W. R. GRACE & COMPANY'S PROPOSED ACTION. THESE MEASURES ARE DISCUSSED IN THREE CATEGORIES: THOSE INCLUDED IN W. R. GRACE & COMPANY'S PROPOSAL, THOSE REQUIRED BY LAW OR REGULATION, AND THOSE MEASURES THAT WOULD BE APPLIED AS SPECIAL CLAUSES OR STIPULATIONS TO LEASES OR PERMITS. IN EACH OF THESE CATEGORIES, MEASURES ARE PRESENTED BY IMPACTED ENVIRONMENTAL COMPONENT. BECAUSE SOME MEASURES LESSEN IMPACTS TO MORE THAN ONE RESOURCE, SOME REPETITION OF MITIGATIONS IS UNAVOIDABLE. ALL MEASURES ARE ASSESSED AS TO THEIR PROBABILITY OF IMPLEMENTATION AND/OR SUCCESS. MITIGATING MEASURES ARE PRESENTED AND ANALYZED AS PROCEDURES THAT WOULD BE REQUIRED IF THE PROPOSED ACTION IS APPROVED.

CHAPTER IV

MITIGATING MEASURES

Measures Included in Applicant's Proposal

Soils and Terrestrial Flora

It is the intention of W. R. Grace and Company that their surface mined lands would be returned to a condition at least as good as that which now exists, and that they would be suitable for wildlife habitat and domestic livestock grazing. At this time Grace is still discussing alternatives to a number of reclamation approaches to achieve their proposed land use goal. As more information is gathered from the various ongoing environmental and engineering studies, or as new technologies develop, the reclamation plan would be modified.

To reduce the impact of loss of native vegetation, W. R. Grace has initiated a four-year revegetation study to determine the suitability and practicality of utilizing shrub species native to the Colowyo mine site. This program simulates the disturbance that would result from surface mining. All existing vegetation was removed from the plots, shredded, and may be mixed with the stripped and mixed topsoils. This material was stored for one season and then redistributed over test plots. A variety of experiments are being conducted to determine which plants and what methods are most suited for revegetation. One is designed to test the adaptability of established shrubs to be transplanted, while another will determine the potential for natural reintroduction of nitrogen into the topsoil material.

Reclamation at the mine would begin immediately with start-up of operations. Vegetation would be removed and shredded, although its usefulness has not yet been determined. A number of approaches are under consideration: the shredded vegetation might be mixed with the topsoil and left to decay; it might be windrowed and burned and the ashes later mixed with the stored topsoil; or the material might be composted for use as a mulch when revegetation begins. Each of these approaches would have a number of inherent problems. Direct mixing of plant materials with the topsoil might tie-up nutrients in the decomposition process which are essential to soil development and plant establishment; seeds of undesirable species might also be introduced into the topsoil material. Burning would volitalize some nutrients, while composting might take too long or prove uneconomical to satisfy reclamation goals. It is the intention of W. R. Grace and Company to investigate each of these alternatives and carry out additional tests on the revegetation test plots.

After vegetation removal, topsoil would be removed by scrapers or other suitable equipment and stored in long mounded terraces outside the mine area. Storage piles would be contoured and seeded with legumes and wheatgrasses to abate erosion, compete with invading weed species, and blend with existing surrounding topography. As the mining sequence allows, some topsoils, upon removal, would be placed directly into surfaces readied by backfilling and grading.

Backfilling, grading, topsoil replacement, and seeding would begin as soon as possible, twelve-eighteen months after opening of the initial cut, so the area of disturbance would be kept to a minimum. In the mature operation, reclamation work would be concurrent with mining; approximately 45 acres of new land would be disturbed annually and an equal number reclaimed each year. The topography of the reclaimed surface would reasonably conform to the existing slopes, being feathered into the contiguous natural surface with concave and convex surfaces designed to recreate a variety of micro-environments. The recontoured surface would be covered with up to 18" of the stored topdressing material; this depth would depend on the requirements of the plant species being used for revegetation. The covered surface would then be roughened by discing, harrowing, chiseling, or combinations thereof to increase infiltration of rainfall and prevent erosion. A rangeland drill would be used to plant legumes and grasses to provide initial cover and stabilization while the shrubs gain establishment.

Broken rock material from initial cuts would be cast into piles on the bottom of Streeter Canyon. As the first piles accumulate in height they would be graded from time to time to attain a configuration less than the angle of repose, but not more than 25 percent grade to increase reclamation potential. Terraces would be made along the pile slopes to impede surface water runoff, and contour furrows placed at the toes to capture any sediment. As first mining proceeds westerly up the canyon, the "F" seam does not outcrop at the western end (according to drilling data). At that time, it might be necessary to make a box cut. Spoil from the box cut would be trucked to the approximate area of the topsoil storage piles, contoured, terraced, and seeded to achieve stabilization until such time as spoil would be utilized for backfill.

To insure early plant cover and slope stabilization, native and introduced grasses would be seeded. A list of these species adapted to the mine site area of Moffat County, utilizing information from the soil conservation service, is given below. The recommended mixture is also given.

Kentucky bluegrass	2 lbs/acre
Manchar bromegrass	4 lbs/acre
Intermediate wheatgrass	4 lbs/acre
Pubescent wheatgrass	3 lbs/acre
Western wheatgrass	3 lbs/acre
Slender wheatgrass	3 lbs/acre
Bluebunch wheatgrass	3 lbs/acre
Yellow sweetclover	2 lbs/acre

The species in this list have proven successful for revegetation of disturbed sites in the Axial Basin area; however, this list will be expanded to include more native species after the results of the revegetation study have been analyzed.

To insure the successful establishment of the grass species recommended for initial plant cover and plant stabilization, a balanced nitrogen, phosphorus, and potassium fertilizer (N-P-K) would be used. Rates of 50-75 lb/acre would be applied depending on a number of variables, one of which is soil moisture conditions. Fertilizers would be applied to produce the most beneficial results. Plans might include applications prior to planting (mixing with the topdressing), after seedling emergence or transplanting, applying slow and fast releasing forms (urea-nitrogen), or a combination of these techniques. Best methods of fertilizer application would be employed depending on results of the revegetation test studies now underway.

All cuts and fills produced in the construction of haul roads and access roads would be stabilized by revegetation.

Fugitive dust would be controlled with water spray distributed by water trucks and other appropriate units where excess fugitive dust exists.

All reclaimed areas would be adequately fenced to prevent use by wildlife or domestic grazing until vegetation is sufficiently established.

Terrestrial Fauna

To mitigate the expected alterations of the existing ecosystem, it would be necessary to make every effort to return disturbed areas as close to existing soil and vegetal conditions as possible. W. R. Grace has stated that it is their intention to return their surface mined lands to a condition at least as good as that which now exists.

Since the design and purpose of the revegetation study is to reestablish native browse vegetation, wildlife studies are in progress to supplement the revegetation tests. The amount of big game utilization per plant species is currently being measured. This information would be used to determine the percentage of each species that should be planted to provide suitable wildlife habitat. Small game studies are also in progress to determine the potential problems that may exist from rodent grazing. In an effort to minimize disturbances, reclamation work would be concurrent with mining; reclaimed acres would equal disturbed acres each year. All reclaimed areas would be adequately fenced to prevent wildlife utilization until the vegetation is established.

Aquatic Biology

A main ditch would be constructed east-west across the eastern half of the property, somewhat below the highest elevation. Two or three intermediate ditches would be located parallel to this ditch but at lower elevations; these structures would be designed to insure that runoff water from precipitation would be deposited in the natural drainage areas. This would mitigate problems with water flowing into areas other than those presently involved.

W. R. Grace and Company has been participating in water studies in the area with Federal agencies to determine quantities and qualities of water produced at the mine site. Specifications of the settling ponds would be based on the results of those studies for effective use. Discharge water from settlement ponds would be monitored at a point prior to release into the natural stream or drainage for applicable State and Federal chemical and sediment standards and treated if necessary.

Aesthetics

All vegetation removed by the mining operation would be shredded to be used later as a mulch or mixed with topsoil or burned. This would prevent the unsightly appearance of scattered slash, though windrowing and burning would result in visual impacts from both the windrows and the burning of them.

Topsoil stockspoil areas would be shaped and seeded to blend with adjacent topography; their greatest impact would occur from the time they are being built until they are revegetated.

Large-scale form and line-dominant minus deviations resulting from spoil piles would remain for three years in the area of the initial mining operation, thereafter spoil piles would be reshaped and leveled. In the mature operation the time lag from mining to the reshaping of spoil piles would be reduced to one year. Establishment of vegetation to mitigate visual impacts of color and texture-dominant minus deviations would occur approximately three years after spoil pile leveling and seeding.

All cuts and fills on access and haul roads would be revegetated and stabilized; this would help mitigate the strong line and form-dominant nature of these minus deviations. However if species similar to those on immediately adjacent terrain are not used, there would be deviations in texture and color from the characteristic landscape.

Fugitive dust would be controlled by spraying water; it should be noted that this type of control would be only approximately 30 percent efficient.

Recreation

W. R. Grace and Company proposes to begin reclamation operations immediately after opening the mine. Reclamation would include regrading of spoils, revegetation of the spoils and road construction scars, and construction of settling ponds and diversion ditches. These actions would significantly reduce mine-caused siltation downstream. This would help maintain downstream fishing capabilities in Axial Basin Reservoir and in the Yampa River.

Measures Required by Law or Regulation

Geologic and Geographic Setting

Paleontology

On July 10, 1963 the Regional Solicitor at Salt Lake held "that fossils are covered by the Antiquities Act but such coverage extends only to such fossils which are of an actual and real historic or scientific interest and of some unusual significance" (Associate Solicitor, Division of Public Lands, October 13, 1971). Title 43 CFR 6010.2(b)(2) prevents removal of ". . .object of antiquity, historic, or scientific interest. . ." However, section 6010.2(a) does allow for collection of common invertebrate fossils, rocks and gem stones for personal use, consumption, or hobby collecting.

Water Resources

Refer to the Regional Analysis for measures required by law or regulation relating to water resources.

Air Quality

Impact on air quality as a result of mining and associated operations is affected by the following laws, regulations and guidelines dealing with air pollution:

a. National ambient air quality standards promulgated by EPA for suspended particulates, hydrocarbons, nitrogen oxides, sulfur dioxide, carbon monoxide, and oxidants (EPA, 1971).

b. "Ambient Air Standards for the State of Colorado", sulfur dioxide and suspended particulates (Colorado, 1970).

c. "Regulation No. 1, Emission Control Regulations for Particulates, Smokes, and Sulfur Oxides for the State of Colorado", Section II. D. Fugitive Dust (Colorado, 1971).

d. Clean Air Act, 1970, Section 110, State Implementation Plans, Prevention of Significant Air Quality Deterioration (EPA, 1974b).

e. Clean Air Act, 1970, Section 110, State of Implementation Plans, Air Quality Maintenance Areas and Plans (EPA, 1973b).

Of these, the first three are existing regulations governing air quality and emissions; the last two are EPA requirements and guidelines that will probably lead to emission regulations in the next several years.

Under the State of Colorado Implementation Plan for achieving air quality standards, the State has enforcement responsibility for all five listed existing or future regulations.

The State Ambient Air Quality Standards are more restrictive than the Federal standards promulgated by EPA for suspended particulates and sulfur dioxide. These and the Federal standards for the other gaseous pollutants will apply to all areas outside the mine property.

Emissions of particulate matter, as well as ambient air concentrations of suspended particulates, are controlled by Colorado law. Ambient air standards are not specific to a source, while emission standards apply directly to each individual emission point and may be different for each source. Enforcement of emission regulations is independent of ambient air pollutant concentrations and thus does not necessitate distinguishing between contributions of several sources. The fugitive dust regulations referenced above in Number 3 prohibit mining operations without a permit that specifies fugitive dust control measures. The following excerpt from page 1.19 of Regulation No. 1, Section 9, indicates some of the control measures that might be required.

List of Abatement and Preventive Measures.

b. Demolition, Wrecking and Explosive Detonation Activities; Earth and Construction Material Moving, Mining and Excavation Activities.

b-1 Abatement and preventive fugitive dust control measures shall be approved by the Division and may include, but shall not be limited to:

- wetting down, including pre-watering;
- landscaping and replanting with native vegetation;
- covering, shielding or enclosing the area;
- paving, temporary or permanent;
- treating, the use of dust palliatives and chemical stabilization;
- detouring;
- restriction of the speed of vehicles on sites;
- prevention of the deposit of dirt and mud on improved streets and roads and other such effective means of dust control as the Division may deem necessary;
- disturbing less topsoil and reclaiming as soon as possible.

b-2 Sequential blasting shall be employed whenever or wherever feasible to reduce the amounts of unconfined particulate matter;

b-3 Such dust control strategies as revegetation, delay of surface compaction and sealing, shall be applied.

b-4 Haulage equipment shall be washed or wetted down, treated, or covered when necessary to minimize the amount of dust emitted in transit and in loading.

The mine development would constitute a new source of emissions of all the regulated air pollutants and would therefore be subject to analysis of significant deterioration of air quality (Number 4) and air quality maintenance planning (Number 5). At the present time, the significant deterioration regulations are under development by the state according to guidelines from EPA. The final regulations will place limitations on ambient air quality degradation in the area of the mine that may include limits more restrictive than the ambient air quality standards. The regulations will probably be written as specific emission limitations, based on expected impact on air quality. But since fugitive emissions are not easily measured, as exemplified by the Colorado fugitive dust regulation which does not refer to the quantity of dust, it is not clear what form the new regulations will take.

The purpose of air quality maintenance planning is to assure that ambient air quality standards once achieved are not exceeded at a later date due to new sources. Baseline air quality in the mine area is presently better than the standards. The air quality maintenance plan now being developed by the State and EPA will address the impact of the mine and any other new or expanding sources in the area. Significant deterioration regulations, if promulgated, will become part of the plan.

Working conditions and employee health and safety are regulated by the Mine Enforcement Safety Administration (MESA).

The gaseous pollutant emissions from the mine would result from vehicle exhausts and fires. The use of automobiles, trucks, and other heavy equipment that comply with EPA vehicle emission regulations would be the only available control measure.

Soils and Terrestrial Flora

Measures provided by Regulation No. 1, Section 9, Emission Control Regulations for Particulates and Sulphur Oxides for the state of Colorado that control fugitive dust, such as road watering, would reduce the impact of fugitive dust on plants and soils.

Measures required by the Colorado Open Mining Land Reclamation Act are described in Chapter VI of the Regional Analysis.

The Endangered Species Act of 1973 provides for the conservation, to the extent possible, of plant species facing extinction. If species in this category were found on the Colowyo mine site their protection would be provided for by enforcement of this act.

Terrestrial Fauna

The Endangered Species Act of 1973 makes it unlawful to harass an endangered species in any way. Peregrine falcons have been sighted over the proposed mine site. A study would be conducted to determine the exact use and value of the proposed mine site for this endangered species before any construction is begun. Should this study determine that the mine site is used by endangered species, then W. R. Grace and Company would have to comply with the Endangered Species Act. This would help mitigate any potential harassment and subsequent dislocation of this species.

In accordance with CFR 30, 211.16, all core holes would be filled with a mud or cement substance to mitigate loss or injury to animals.

Aquatic Biology

See surface water section of Regional Analysis for mitigating measures for Aquatic Biology required by law or regulation.

Archeological Resources

Legislative backing for protection of archeological resources comes from a variety of legislation. The Regional Analysis contains a detailed account of these regulations which are only summarized in this section.

The 1906 Federal Antiquities Act makes it illegal to damage, destroy, appropriate, or excavate any historic or prehistoric object, and it requires the issuance of antiquities permits to qualified professionals for purposes of conducting surveys, testing, and excavation.

Authorization for the Secretary of the Interior to maintain the National Register of Historic Places is given by the 1966 Historic Preservation Act; the Advisory Council on Historic Preservation is also established by this Act. All Federal actions affecting existing or proposed National Register Properties must be reviewed by the Advisory Council (according to Section 106 of the Act).

The National Environmental Policy Act of 1969 also identifies the Federal government's continuing responsibility to preserve important historic and cultural aspects of our national heritage.

Establishment of the Federal government in a leadership role of preserving, restoring, and maintaining cultural resources was accomplished by Executive Order 11593, 1970.

Protection of cultural resources on the State level is given by the Colorado Antiquities Act of 1973 which is essentially a parallel form of the Federal Antiquities Act. The Colorado Land Use Act of 1974 further authorizes local governments to designate cultural resources as areas of State interest with commensurate protection.

Most recent Federal legislation is the Archeological and Historical Data Conservation Act of 1974 which requires protection of cultural resources affected by any Federal or Federally-licensed construction project.

Two relatively recent solicitors' opinions further clarify the law's intent. An opinion issued in September, 1974 declares, with respect to privately-owned surface acreage underlain by Federal mineral and coal lands, that the Section 106 Advisory Council review provisions are applicable. In addition it states that BLM has a NEPA responsibility to identify and consider the effects of its programs on cultural resources of these lands. Lastly the final responsibility for inventory and nomination to the National Register of cultural resources on these lands rests with the agency responsible for approving the potentially impacting action, which is the BLM.

A second solicitor's opinion of April, 1974, indicates that professional cultural resource surveys must be required as a part of the applicant's mine plan.

In order to identify all cultural resource values adequately to satisfy Section 106 requirements of the 1966 National Historic Preservation Act, an intensive archeological survey must be completed. Dr. Lischka's completed cultural resource study fulfills the law's requirements.

For all practical purposes, not all cultural values having surface evidence will be identified in the required survey. In addition other sites may be buried by alluvium and hidden from view. The regulations themselves would also do little to prevent theft and vandalism of cultural resources due to increased visitor use pressure.

Historical Resources

All current antiquities legislation enumerated in the Archeological Resources section is also applicable to protection of the area's historical resources.

Aesthetics

Regulation No. 1, Emission Control Regulations for Particulates, Smokes, and Sulphur Oxides for the State of Colorado, Section II-D, Fugitive Dust, (Colorado, 1971) prohibits mining operations from occurring without a permit that specifies fugitive dust control measures. These measures can be implemented to reduce atmospheric haze that results from airborne pollutants and particulates.

The Colorado Department of Health's water quality standards (1974) provide regulations consistent with the provisions of the Federal Water Pollution Control Act amendments of 1972. The waters of Good Spring and Milk Creeks plus adjoining tributaries are thereby required to be free from the aesthetically damaging effects of floating debris, scum, and discoloration.

Colorado's Open Mining Land Reclamation Act of 1973 directs the mine operator to assume several duties in Section 92-13-6 of the act. Part 1-c dictates that spoil pile peaks and ridges be graded to a width of not less than 15 feet and that a gently undulating skyline be maintained. This regulation will help mitigate the strong line and form-dominant minus deviations of surface mine spoils and will ensure that the Colowyo Mine spoils will at least be partially graded.

Part 1-f of the same section in the preceding act also directs refuse disposal in a manner that will control stream pollution and unsightliness. W. R. Grace and Company is thereby constrained to maintain a litter-free environment by providing for an unobtrusive sanitary landfill and by maintaining an overall litter-free landscape.

Part 1-a, Section 92-13-6, of Colorado's Open Mining Land Reclamation Act provides for consultation between the State Land Reclamation Board, the County Commissioners, and the local board of supervisors of the soil conservation district. This required consultation process will provide opportunities for the reclamation board to learn of aesthetically sensitive areas at the Colowyo Mine and to take appropriate action to mitigate impacts to visual resources.

Impacts to mood-atmosphere values that would be caused by increased noise levels could be partially mitigated by implementing the provisions of Colorado Senate Bill 197 (1971) which establishes maximum permissible noise levels and abatement procedures. Federal noise pollution guidelines are outlined in P.L. 91-604, The Clean Air Act, Section 401 -- Noise Pollution and Abatement Act of 1970. The Office of Noise Abatement and Control, established by this Act, provides for enforcement of the guidelines contained in the Act. Enforcement of these laws would achieve the lowering of noise levels adjacent to the Colowyo Mine.

The above legislative acts will be effective only to the extent that they are enforceable, that the standards set forth are enforced, and that these minimum standards are indeed effective in reducing impact. The probability of all of these actually being enforced, on the ground, is something less than 100 percent as evidenced by impacts presently occurring from similar ongoing operations in the region.

Recreation

Water quality standards established by the Colorado Department of Health (1974) also provide regulations that can be used to mitigate impacts to recreation resources. All state waters should be free of substances or conditions that are toxic to plant, animal, or aquatic life, that produce undesirable aquatic life, and that impart any undesirable taste to fish flesh or make fish inedible. These regulations prohibit mine-caused damage to the recreational potential of downstream fisheries in Axial Basin Reservoir, Yampa River, and adjoining tributaries.

The Colorado Open Mining Land Reclamation Act of 1973 contains several provisions for mitigating recreation impacts. Section 92-13-6 describes the duties of mine operators. Part 1-f directs the disposal of refuse in a manner that will control stream pollution, siltation and other damage to streams and water courses. This regulation also prohibits actions which would indirectly impact downstream recreational fishing potential.

Part 1-g of the same act directs the operator to determine the reclaimed use of the mine, and it provides for this determination in consultation with the local board of county commissioners, as well as with the board of supervisors of the soil conservation district. This would provide input from other land-use decision makers who could determine and direct reclamation efforts to respond to the growing demand for recreational facilities.

The recreational value of archeological and historical resources will be protected by enforcement of the provisions of current Federal and State Antiquities Legislation. These include the Federal Antiquities Act (S.4698, June 8, 1906) which makes it illegal to appropriate, excavate, injure or destroy any object of antiquity; this act also requires issuance of permits to qualified applicants for survey or excavation on Federal Lands. The Historic Preservation Act (P.L. 89-665, October 15, 1966) establishes the National Register of Historic Places; it also requires a review of all

Federal actions affecting existing National Register entries by the President's Advisory Council on Historic Preservation. Executive Order 11593 (May 13, 1971) expanded P.L. 89-665 to provide a review of any Federal action affecting properties eligible for inclusion in the National Register of Historic Places. Section 101(b)(4) of the National Environmental Policy Act of 1969 (P.L. 91-190, January 1, 1970) directs the preservation of "important historic, cultural and natural aspects of our national heritage. . ." The Archeological and Historical Data Conservation Act of 1974 (P.L. 93-291, May 24, 1974) provides for the preservation of antiquities "which might otherwise be irreparably lost or destroyed as a result of any alteration of terrain caused as a result of any Federal construction project or Federally licensed project, activity or program."

The Colorado Antiquities Act (H.B. 1569) reserves all antiquities on State-owned lands to the State of Colorado and prohibits the destruction, appropriation, injury, or excavation thereof; permits are also required for qualified applicants to conduct surveys.

The degree to which these legislative enactments will be successful in mitigating impacts will be dependent upon their enforceability and actual on-the-ground enforcement. Based upon past observations of similar coal mining operations, enforcement of current laws has not been completely effective in mitigating applicable impacts.

Transportation Networks

The measures applicable to transportation considerations are covered in detail in Chapter VI. of the Regional Analysis. W. R. Grace has stated its intentions to meet all such requirements in its transportation plans (e.g. rail line and coal-hauling by truck).

Measures to be Included
if Authorizations are Granted

Geologic and Geographic Setting

Topography

Plans would be made in advance for what the topography should be during and after mining to avoid hazards and damage, such as landslides, slumps, erosion, and deposition. Final topographic expression of the mined area would be determined before mining begins. Early planning and monitoring of spoil versus original volume would prevent accumulation of excessive amounts of spoil with no place to put it without creating topographic anomalies. Good planning would prevent large unsightly randomly placed spoil piles and waste.

Drainage ditches uphill from the mining operations would run to the middle of natural drainages into which they discharge; this would prevent gully erosion and sedimentation downhill from their end as shown by the company's map.

W. R. Grace would strive for a more subdued topography, replacing present steep slopes with gentle ones, rather than try to copy present topography precisely in their reclamation work. This would aid in retarding erosion and preventing landslides, mudflows, soil creep, and similar problems. The present strongly convex aspect of the site, with its steep slopes northward into Streeter Creek valley, would be changed to a more concave aspect in order to reduce these slopes. Where high natural slopes are topped by spoil, a low profile would be formed on the spoil; where high bluffs overlooking Good Spring Creek are mined, they would be changed to more gentle slopes by placing less spoil there.

Stratigraphy and structure

There are few areas where multiple coal beds are mined by surface methods, as is the case in W. R. Grace's plan. The proposed mining provides a unique opportunity for the continuous study, during the life of the mine, of these coal beds and all their stratigraphic and structural relations. Such a study, perhaps undertaken by one or more universities, would be very useful in the understanding of coal deposits elsewhere, and would provide sufficient mitigation for the loss of the local stratigraphic and structural record. Mining engineering practices might also be improved by such a study.

Geomorphology

The mine would be a mobile geomorphic form during its life. Its anomalous appearance on the general landscape would be mitigated by mining practices which utilize as little of the surface as possible at any given time.

The letter of July 15, 1975 from the company to the Area Mining Supervisor states that:

> The topography of the reclaimed area will reasonably conform to the existing slopes, being feathered into the contiguous natural surface with concave and convex surfaces designed to recreate a variety of micro-environments.

The practice of feathering in the reclaimed area to adjacent natural landforms would tend to lessen the impact on the landscape. If the company strives for a more concave overall surface rather than the present convex one (as suggested in the section on Topography), and proceeds with the smaller "concave and convex surfaces" mentioned in its letter, the result would be an undulating surface that would provide a pleasing change from the more severe original landforms.

Valleys that are artificial, shallow, and wide would be constructed across reclaimed areas. These would be designed to receive runoff from natural drainages higher up and to allow drainage with a minimum of erosion. Ideally they would ultimately assume the appearance of natural intermittent stream valleys.

Water Resources

The sum of all of the various mitigating measures would reduce the sediment yield from the reclaimed mine spoils by about 90 percent, for a total annual reduction of 315 tons. The mitigating measures would reduce the sediment produced from road construction by about 80 percent, for a total reduction of 450 tons.

Air Quality

Control of the largest source of pollutant, fugitive dust, is expected to be part of mine operations. There are several other considerations besides ambient air pollution which mandate control of fugitive emissions. The most important concern is employee health and safety.

Fugitive dust from mining operations might be a safety hazard due to impairment of worker visibility, increase in the risk of accidents, or interference with safety equipment. Another consideration of dust control is the efficiency of overburden and coal handling which is improved if the quantity of fines and the amount of airborne dust is limited.

A wide variety of control measures are possible to help prevent the generation of fugitive dust (see the list in the last section). The most common method for dust control on surfaces is the application of water to agglommerate fine particles and thus prevent them from becoming suspended in the atmosphere. Watering is only as efficient as the success in keeping the disturbed material (either by wind or mechanical action) wet. In the dry Colorado climate, this can be very difficult. Over-watering must be avoided because of the obvious safety hazards of mud on non-level surfaces. On haul roads that are semi-permanent, an additive such as a petroleum-based material can be used to form a crust that approximates the effect of paving. Water can also be applied on surfaces other than roads to dampen material about to be moved.

Fugitive dust from process operations is controlled by watering at transfer points, such as conveyor ends or loading stations. The placement of hoods, connected to a ventilation and dust collection system over sources such as crushers and sorters, limits emissions from mechanical treatment of coal. General cleanliness and the prevention of spills help to reduce the amount of fugitive dust.

Particulate matter would be forced into the atmosphere in the blasting operations, but the amount that remains airborne could be controlled sufficiently if care is taken in the blast design. The function of blasting, the break-up of material so that it can be moved, should be accomplished without the production of a large fraction of very small particles, by proper sequencing and control of amounts of explosive.

Coal fires as a source of pollutants should be minimized by careful design of overburden piles and preventive action. Once a fire starts, only prompt, thorough fire fighting could prevent a major air pollution problem.

A major mitigative measure for the control of fugitive dust would be the reclamation of the mine surfaces. As mining proceeds, reclaimed areas would be expected to cease to be sources of fugitive dust. Reclamation would include grading, vegetation planting and other landscaping.

Other less conventional control measures are available for fugitive dust. Such practices as road paving, covering of surfaces or hooded trucks, maintaining low vehicle speeds, limiting operations during very dry periods, limiting operations at night or other times during periods of poor atmospheric dispersion, applying chemical treatments, installing barriers, and planting temporary vegetation could be utilized. However, the cost effectiveness, efficiency, and practicality of such measures has not been adequately determined.

Soils and Terrestrial Flora

To best mitigate the loss of existing soils and vegetation, a detailed reclamation plan would be developed before the mining operation begins.

Mechanized equipment such as scrapers would be used for both stockpiling and replacement of topsoil, to minimize soil mixing with other less desirable geologic material; productive soil would not be buried or mixed with unproductive overburden or toxic material. Toxic or other undesirable material such as moderate to high sodium layers would be buried 60 inches or more below the surface.

The lessee would provide the BLM detailed soil and overburden (geologic strata between the soil and strippable coal seams) information on the area to be mined as follows: (This is to supplement information now available and to insure that mitigating measures can be accomplished.)

1. Describe detailed soil inventory (survey) map of the lease area and corridors to standards by the BLM (Family Level of Classification, Soil Conservation Service) to determine location, extent, and thickness of topsoil;
2. Sample soil and overburden down to the first coal seam and between seams for chemical and physical data, to determine the presence or absence of toxic material (that affect plant and animal life), and to record depth and thickness of the layer according to standards designated by the BLM:
    a. Determine suitability of present soils for reclamation supported by chemical and physical data according to standards designated by the BLM;
    b. Describe the present physical character of overburden and the anticipated product when disturbed;
3. Determine present soil moisture relationships before mining by determining climatic conditions on the lease area (precipitation, temperature, potential evapotranspiration).

After mining proceeds every effort would be made to remove topsoil from areas to be mined and replace directly on reshaped spoils. Immediate replacement of topsoil is most desirable where wildlife habitat is the proposed land use, because some native plant species and micro-organisms would be transplanted live, thus speeding reclamation of the mined area.

If possible, topsoil stockpiles would be placed on areas to be mined or already mined so additional vegetation is not destroyed. In areas where topsoil is found in large quantities, it would all be removed before mining and stockpiled so it can be replaced on areas where topsoil is lacking.

If possible during the overburden removal process fragmented material below the topsoil would be placed on top of spoil piles. This material has proven usable as a plant growth material in the area, and would provide a good growth media for deep-rooting plants, and speed the soil building process because of its fragmentation.

If spoil material from the original boxcut is to be stockpiled for more than five years, topsoil would be removed from the storage area before storage, replaced on the surface of the boxcut spoils, and permanently revegetated.

Seeding of perennial vegetation would be confined to fall or spring to insure best possible seedling establishment. On areas returned to wildlife habitat seed mixtures would be varied according to microclimatic conditions produced by the shaping process.

W. R. Grace is evaluating the possibility of transplanting native trees and shrubs from unmined to reshaped areas to return the land to wildlife habitat. This program would be utilized to the maximum extent possible to mitigate the loss of existing shrub and tree vegetation. Trees and shrubs, especially aspens, would be transplanted to areas of most favorable soil moisture conditions produced by the shaping and topsoil replacement operations; transplanting would be accomplished when trees and shrubs are dormant.

Spoil material in Streeter Canyon would be returned to shrubs so these deep rooting species can stabilize the spoil and mitigate the loss of existing shrub vegetation from this area.

When W. R. Grace's final seeding mixture or mixtures are developed, they would utilize as many native species as possible and include introduced species that have produced well on mine spoils in the area.

Road cuts and fills would be seeded as soon as possible following construction to minimize erosion. If construction is completed in spring or fall, perennial vegetation would be seeded; otherwise annual grass would be seeded to provide temporary erosion control and compete with invading weed species.

When climatic conditions are such that seedings fail, reseeding would be implemented until vegetation is established. If localized adverse soil conditions are such that vegetation will not establish, the area would be covered with at least 18 inches of suitable material and revegetated.

In areas of extremely adverse soil moisture conditions or very steep slopes, a mulching practice such as straw or hydromulch would be utilized to increase revegetation potential. Where slopes are greater than 33 percent a surface manipulation practice would be implemented to impede runoff and induce infiltration. This would increase success of revegetation attempts.

After topsoil replacement, if fertility levels are too low for seedling establishment, fertilizer would be applied shortly after seedling emergence, unless seeded in the fall, in which case it would be applied in early spring following seeding. If soil fertility levels are adequate for seedling establishment but not for sustained growth, fertilizer would be applied in early spring of the second growing season.

Berg (1975) found that the application of adequate nitrogen (N) for good initial ground cover on sandy uranium spoils in northwestern Colorado had a short-lived effect on very N-deficient spoil material, and that considerably more N would have to be applied before a self-maintaining system can be expected. This N can possibly be supplied after a few years by planting N-fixing species, but creates impacts described in Chapter III of the Regional Analysis. Where soil fertility rates are very low and plant growth is deficient, a maintenance fertilization program would be implemented until the soil system is self-maintaining.

Berg (1975) felt that the most important reason to replace topsoil is to supply N. He stated that an acre of soil one foot deep containing 0.1 percent N (a fair average for Colorado) has a N content of about 4,000 pounds, which in terms of current fertilizer prices would be worth approximately $1000. The long-term cost of adequate fertilizer N where not supplied by N-fixing plants might well exceed the cost of topsoil replacement.

Terrestrial Fauna

Existing roads would be used whenever possible to reduce vegetation disturbance during the exploration phase. All disturbed areas such as temporary roads and drill pads would be reclaimed.

Topsoil removed from the initial cuts would have to be stockpiled. To mitigate the impact to the ecosystem such areas would be located where the degree of damage would be minimal. All soil would be placed within sagebrush vegetation type to avoid disturbing mountain shrub type. After the initial cuts have been made all new stockpiled soil would be located on spoil piles so no additional areas will be disturbed.

W. R. Grace would work closely with the DOW to insure that game populations within the lease area are managed in accordance with regional plans; access for proper game harvesting should be encouraged.

All off-road-vehicle use would be prohibited to reduce impacts on vegetation and soil productivity.

Ponds and stocktanks would be created on reclaimed spoils as soon as possible to mitigate water losses caused by mining similar areas, and the covering of Streeter Creek by mine spoils.

All roadsides would be seeded to hold the soil and reduce sediment runoff. This reseeding would be done as soon as possible after completion of the road construction phase. To reduce the probability of vehicle-animal collisions plant species used for revegetation would be those that would not draw wildlife to roadsides.

To reduce the impact of the proposed haul road, all cut material would be taken out of the area and deposited on existing spoil piles, rather than pushed over the side of the road. This would decrease the amount of disturbed vegetation. Spoil areas would be used whenever possible for roads to reduce the impact on undisturbed areas.

All pad areas and roads created during the installation of the 69-kv powerline would be reseeded as soon as possible after the powerline construction. Vegetation between power poles would not be disturbed unless absolutely necessary.

High rodent populations expected to utilize revegetated areas would reduce natural capabilities to quickly establish a self-sustaining floral cover. To mitigate this impact it would be necessary to attempt to control these rodents.

Aquatic Biology

The amount of increased surface erosion and stream sedimentation in the analysis area would be minimized by the following measures: (1) all road cuts would be protected from erosion by riprapping with logs or rocks above and below the cuts, and the disturbed areas would be revegetated as quickly as possible following construction; (2) erosion from all disturbed surface areas associated with the proposed mining activity would be controlled by the design and utilization of a drainage ditch and settling pond system; (3) a sump system at the open mining pit would help keep sediment-laden waste water in the stripped area; and (4) all areas in which the surface would be disturbed as a result of the proposed action would be protected by erosion control devices (e.g., waterbars, drains) until reclamation is completed.

As problems are noted during proposed mining activity, additional settling ponds and other flow control structures would be constructed along drainageways.

Archeological Resources

Archeological values derive their primary value from being preserved in-place; their secondary value occurs as an archeological dig. No archeological testing nor excavation that stems from the intensive survey would be permitted unless the site is in imminent danger of being destroyed (see Table GIII-5). This would preserve the site's primary value and subsequent educational-interpretive values as well. It would also allow utilization of improved archeological survey and analysis techniques should the site be excavated at a future date, when more sophisticated techniques could be employed in the excavation. For all practical purposes, this guideline might not be followed for especially significant sites.

Those sites subject to partial or complete physical displacement and which were recommended for further testing (numbers 2 and 4, Figure GII-14 and Table GIII-5), would be tested prior to surface disturbance, and subsequently salvage excavated if necessary.

Impacts to subsurface archeologic values would be partially mitigated by requiring that an archeologist accompany construction crews while working in recently deposited alluvium suspected of containing subsurface values. This is usually done at the recommendation of the surveying archeologist. Not all subsurface resources would be found in this manner, for there is no foolproof method for determination of subsurface archeological potential.

Historical Resources

Historical resources also derive their primary value from being preserved in-place; their secondary value is realized if they are excavated. Sites number four and five (Figure GII-14 and Table GIII-5) would be tested and then subsequently excavated, if desirable, prior to initiation of surface-disturbing actions.

Other historical sites would not be excavated unless they are subject to complete or partial displacement.

Aesthetics

When trees and shrubs are removed from road and facility construction or for mining itself, clearings would follow an irregular pattern to simulate natural openings. Determination of this irregular line would be based on picture planes as seen from the viewshed sequences providing the view (see landscape visibility maps in Chapter II).

When trees or shrubs are removed, they would not be piled nor scattered but would either be buried or returned to the site during reclamation as a mulch after chipping them.

All mine spoils would be thoroughly leveled to a gently rolling landscape that complements the adjacent topography. Spoils into Streeter Canyon would conform to an undulating contour similar to that of the present hillside. The contact of the spoils with the then undisturbed south-facing slope would be bladed into a rounded bottom to avoid creation of an unnatural line-dominant feature.

No spoils or road fill material would be dumped nor spilled onto the steep slopes lying adjacent to Good Spring Creek below the proposed haul road.

Where the main haul road is to traverse mine spoils in Streeter Canyon, it would not be built by cutting and filling. Instead, the road should be built as the spoils are reclaimed so that slopes immediately adjacent to each shoulder will be an integral part of the reclaimed surface.

Where the main haul road is to cross the draw in SW 1/4 SE 1/4, Section 2, the fill would be shaped so its contact with natural terrain will be at a low angle, rather than at right angles. By approximating the terrain at the head of the Canyon, the fill can borrow form from the adjacent terrain.

Spoil reclamation visible from Colorado Highway 13 would occur on a priority basis as soon as possible after stripping. Throughout the mining area revegetation with native species arranged in an irregular pattern would also help camouflage impacts.

Construction of the main haul road on the east side of the pit, above Highway 13, would be only on the cut. All material excavated would be hauled to the spoil area; none would be used in constructing the road. The berm of spoil proposed on the downhill side would instead be a natural berm that results from cutting down past the present surface. This would avoid dumping spoil on slopes adjacent to Good Spring Creek where it would be visible as both foreground and background.

Stockpile areas for spoils and topsoil that are proposed west of Streeter Canyon would be rounded and shaped irregularly, rather than geometrically, to blend with the adjacent terrain. Successful revegetation with indigenous species in an irregular pattern would also help camouflage stockpiling areas.

The substation would be placed at the naturally occurring edge between the steep scrub oak hillside and the grassy meadow. It would be screened by or constructed of a non-reflective warm green, brown or buff color to help it blend with the characteristic landscape.

Transmission power poles and cross members would be penta treated. Creosote treated poles would not be used because of their black color. Non-reflective electrical conductors are also available and would be used on that portion of the line visible from Colorado Highway 13 to eliminate glare from the afternoon sun. No vegetation clearing would occur on the area of the transmission line right-of-way, and no roads would be constructed to provide access alongside it. These construction practices would be adhered to on all areas that would not be stripped and that are visible from public roads.

Intermediate and final crushing and loadout facilities would also be constructed or screened as outlined above to reduce their visual impact.

Proposed mine office facilities adjacent to Moffat County Road 17 as well as crushing and loadout facilities and the conveyor would also be painted a non-reflective warm green, brown or buff color to enable them to borrow color from the adjacent landscape. Silver metallic surfaces would be avoided. Avoiding high-profile buildings would also mitigate intrusiveness by enabling them to more easily borrow from the horizontal form of the characteristic landscape.

The mine access road as well as all other haul roads would have their adjacent cut and fill slopes revegetated immediately after construction. Use of native shrubs and grasses would lessen their impact in terms of form, color, and texture. All mine access and other haul road cut and fill slopes would also be backsloped in a rounding grade that meets the adjacent terrain at a very low angle, feathering into the natural landform.

Regular sprinkling with water or oiling would be required to control road dust on coal haul roads and on the mine access road.

W. R. Grace would concentrate on maintaining a litter-free environment by having a regular cleanup program to properly dispose of waste, litter and discarded equipment. They would establish sanitary landfills that are either not visible from public roads or are screened; screening fences would also be used to prevent windblown litter.

Recreation

To reduce siltation caused by disturbance of alluvial material, and subsequent damage to downstream fishing potential, all surface disturbing activities would be restricted from floodplain alluvium if sediment control structures are not employed. Disturbance of steep slopes immediately adjacent to floodplains would also be avoided for the same reason.

Increased safety for recreators and sight-seers on public roads would be promoted by prohibiting overburden dumping and pushing of fill material over escarpments or steep slopes, such as those that lie west of Good Spring Creek. Also at least one quarter mile of the haul road adjacent to its intersection with Colorado Highway 13 would be paved to keep trucks from tracking rocks and gravel on to the highway; this would help maintain highway safety for passing motorists. An additional northbound acceleration traffic lane would be constructed on Colorado Highway 13 beginning at the haul road intersection. This would also allow coal haul trucks to discard wedged rocks from between dual wheels before entering the mainstream of traffic.

Impacts to the inherent recreational capabilities of Cultural Resources would be mitigated as outlined in Chapter IV, Archeological and Historical Resources.

Earth mounding and shaping techniques may be employed to increase recreational opportunities on mined-over areas Within the basic rolling vegetative type, waterways and ponds would be constructed to increase aesthetic attractiveness and wildlife viewing opportunities. Mounding and shaping would create more ecologic niches and additional cover for more wildlife.

Chapter V

Adverse Impacts Which Cannot Be Avoided

THIS CHAPTER PRESENTS THE RESIDUAL ADVERSE IMPACTS OF W. R. GRACE & COMPANY'S PROPOSED ACTION THAT WOULD REMAIN AFTER APPLICATION OF THE MITIGATING MEASURES DISCUSSED IN THE PRECEDING CHAPTER. THE FOLLOWING DISCUSSION COMPLETES THE ANALYSIS EQUATION: IMPACTS MINUS MITIGATIONS EQUALS ADVERSE IMPACTS WHICH CANNOT BE AVOIDED.

CHAPTER V

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Geologic and Geographic Setting

Topography

Replacement of a few hundred feet of natural strata with mine waste materials of broken sandstone and finer grained rock fragments would change the topographic, water-retaining, and erodibility characteristics of the site; this cannot be avoided. Change from the present natural configuration of the surface to a man-made landscape would be unavoidable under any surface mining plan; whether these changes are adverse to the topography depends on the mitigating measures adopted.

Partial filling of lower Streeter Creek valley, as the company plans, is necessitated by the fact that the lower coal beds to be mined crop out at lower elevations on the south side of this valley. If the valley's present depth and configuration were maintained, it would mean that an unacceptably steep high south bank of spoil material would be constructed.

Stratigraphy and Structure

Removal of part of the stratigraphic and structural record of the Williams Fork Formation would be unavoidable under the surface mining plan.

Geomorphology

Land forms removed and replaced are not unique so this in itself would not constitute an adverse environmental effect. An adverse effect would result if the newly constructed land forms could not attain equilibrium with the surrounding environment, or if they present a very anomalous appearance in the general landscape.

Paleontology

Impacts to all fossils would be difficult to mitigate; some would most certainly be destroyed. Generally speaking, these losses would not be significant as the fossils occur randomly in the formations to be mined.

Mineral Resources

Mining and removal of coal cannot be avoided under present plans, proposals, and energy shortage conditions. Therefore, the proposed mining would have an unavoidable impact on coal resources in that about 93 million tons of this nonrenewable energy source would be removed. Loss of about 10 percent of mined coal during mining, loading, and transportation would be unavoidable, primarily because of the size of the equipment used to make this an economic enterprise.

Water Resources

Ground Water

There are no significant adverse environmental effects with respect to ground water that cannot be avoided. The unavoidable sediment yield from the mine would be about 35 tons/year and the unavoidable sediment yield from the new roads would be about 120 tons/year.

Surface Water

There would be some increase in sedimentation in Good Spring Creek and Axial Basin Reservoir as a result of the proposed mining activity, particularly road construction. However with the proper placement and utilization of settling basins around proposed construction areas, this adverse impact would not be significant.

The proposed mining activity would unavoidably destroy minor intermittent drainages in the analysis area. This impact would produce concurrent alterations in the local surface water flow patterns and cause significant increases in erosion during severe summer thunderstorms and spring runoff.

Air Quality

The air quality during mining operations would be degraded in terms of all the presently regulated pollutants: suspended particulates, carbon monoxide, oxidants, sulfur dioxide, nitrogen oxides, and hydrocarbons. Mining cannot be performed without air pollutant emissions from vehicles and the generation of fugitive dust.

Visibility in the vicinity of the mine would be decreased because of mine air pollutant emissions. Estimates indicate that total suspended particulate regulations would be exceeded near the mine. No other degradation in excess of standards would be expected.

Soils

Disturbance of soil could not be avoided, Table GV-1. Loss of productivity would be unavoidable. Soil disturbance might lower natural soil productivity of the area to some degree by compaction, mixing natural soils and causing accelerated erosion and sedimentation.

TABLE GV-1

Acres of Soil Disturbance Associated with the Proposed W. R. Grace Mining Operation

Mine/Period	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Grace	195	201	240	211	218	214
Facilities	25	-	-	-	-	-
Off-site Topsoil and Boxcut Spoil Stockpiles	80	-	-	-	-	-
Access Road	32	-	-	-	-	-
Haul Road	83	-	-	-	-	-

Estimated from Dames and Moore, exact location unknown.

On the area to be mined, partial alteration of all soil horizons, parent material and soil characteristics which have developed over long periods of geologic time cannot be avoided. Present soil biota and soil forming processes would be affected. Once mining is completed and the area reclaimed, soil development would have to start again. As an end result, new soils will be formed with characteristics totally unlike those existing prior to mining.

Terrestrial Flora

Approximately 1,600 acres (see Table GIII-3) of existing vegetation would be unavoidably destroyed during the 30 year life of the mine by roads, stockpiles, facilities, the mining operation itself (1,499 acres), and associated population increase (96 acres). Vegetation would be permanently removed on approximately 245 acres due to the construction of roads, permanent facilities, and population increase.

The existing stage of plant succession would be unavoidably lost when vegetation is removed. Return to native vegetation would depend upon prompt and successful reclamation efforts. If W. R. Grace can return their mined lands to conditions suitable for wildlife habitat and livestock grazing, and utilizes native species to do so, the unavoidable loss of existing vegetation would be reduced.

The soil and microclimatic conditions produced after mining might be very different from existing conditions, making it impossible to establish and sustain native vegetation. On spoils where topsoil has not been replaced nor much shaping done, very little invasion of native species has taken place in 10-15 years (Chapter III Regional Analysis); if replacement of topsoil does not encourage invasion, loss of existing conditions would be an unavoidable impact. Even on areas successfully revegetated, a ten percent reduction in productivity has been projected.

Terrestrial Fauna

Noise created by heavy equipment could result in an unavoidable adverse impact on most wildlife species; this might benefit some animals by driving them away from the construction areas before they are killed. The probability of vehicle-animal collisions would increase with an increase in human activity. This could not be avoided without the construction of fences and passes over or under the roads. Traffic on the proposed roads is not expected to be heavy enough to justify fencing at this time.

Nest and den destruction cannot be avoided when large tracts of vegetation are disturbed. Removal of vegetation, topsoil and overburden would be an unavoidable impact under the existing mine plan. A result of the loss of vegetation and topsoil would be a permanent loss of the existing ecosystem; habitat components and exact faunal species composition ratios would not be returned to their present status.

Impacts on wildlife habitat resulting from dumping spoil material into Streeter Canyon could not be mitigated without changing the type of mining operation.

The one-year time lag from removal of topsoil to beginning of reclamation work would be an unavoidable impact, because reshaping could not be done in close proximity to the ongoing mine operation for safety reasons.

Loss of small mammals, reptiles, amphibians, young unfledged birds and invertebrates that are not mobile enough to escape from the mining progression could not be mitigated without trapping and transporting animals out of the mine area. Displacement of more mobile species of wildlife such as deer, elk, coyote, fox, and fledged birds from the mining area could not be mitigated. The increased probability of spreading disease and parasites due to the increase in animal densities on lands adjacent to the mined areas would also be unavoidable; however, this would most likely be on a small scale relative to the study region's total population. Interspecific and intraspecific intolerances would become evident in some species, such as sage grouse, especially during the breeding seasons. Loss of rabbit and hare habitat, as well as displacement of bats, would be unavoidable under the present proposed mining operation.

Maintenance buildings and offices are needed on the site; therefore loss of vegetation, representing wildlife habitat, resulting from clearing of these areas would be unavoidable unless they can be located on spoils rather than on previously undisturbed areas.

Expected increases in rodent populations during the revegetation program would almost certainly result in a corresponding but time-lagged increase in the numbers of coyotes, fox, snakes, and raptors. Although predator control is possible at least to a limited degree, the increase in predator numbers was included in this section because they should be allowed and encouraged to use the area. Predators act to help limit rodent numbers; this in turn aids in the establishment of the revegetated areas sooner. Therefore no action should be taken to mitigate the increase in predator numbers.

Fencing of revegetated areas would be necessary to protect seedling grass, forbs and shrubs, even though it would alter deer, elk, livestock and other animal species' movements. Removal of all livestock from the vicinity of the ongoing mining operation would be necessary to avoid accidental loss due to equipment-animal collisions or animals falling off the highwall.

Off-site loss of habitat for a variety of wildlife species due to the population increase related to mine construction and operation would be unavoidable.

Fencing-off revegetated areas to exclude livestock grazing for a period of two growing seasons would be needed to allow new vegetation to become established. This 20-25 AUM loss in livestock forage would be an unavoidable impact. Traffic on proposed haul roads and access roads might cause unavoidable harassment or hazards to livestock.

Aquatic Biology

There would be some increase in sedimentation in Good Spring Creek and Axial Basin Reservoir as a result of the proposed mining activity, particularly road construction; this increase in sedimentation would impact the aquatic ecosystem, particularly the sedentary benthic invertebrate and periphyton organisms. However with the proper placement and utilization of settling basins around proposed construction areas, this adverse impact would not be significant.

Archeological and Historical Resources

Any presently unknown archeological sites occurring on the mine property would be subject to damage by direct surface disturbance, and could also be subject to vandalism and pothunting. Destruction of unknown subsurface resources would also be unavoidable; the significance of this impact would depend upon the nature of the unknown resource. Other impacts would also result from required as well as unnecessary excavation of significant archeological sites.

Displacement of known sites identified in Chapter III (see Table GIII-5) would be unavoidable; however testing and excavation prior to surface disturbance would salvage some of their value, but their inherent in situ value would be lost.

As with archeological values, presently unknown historical features could be subject to impacts from surface disturbance, vandalism, and pot-hunting. Displacement of sites identified in Chapter III would be unavoidable.

Aesthetics

Given the mitigating measures discussed in Chapter IV, the net residual of adverse impacts should be significantly reduced; however the proposed action would still alter the characteristic landscape, and for all practical purposes, several visually incongruous elements or minus deviations would not be mitigated.

Adverse aesthetic impacts in Streeter Canyon would not be totally mitigated. During the first two years of operation before reclamation begins, all impacts identified from dumping spoils into the canyon would remain. Thereafter other impacts would remain until the spoils are revegetated, and this portion of the haul road would always be visible, though for a short distance.

Adverse impacts from the main haul road fill that is proposed west of viewshed sequence KL would remain until successful revegetation of the fill occurs. The strong line-dominance of the road would remain during the life of the mine and longer if it is not itself reclaimed.

Visual impacts of that portion of the mine visible from northbound traffic on viewshed sequence JK would remain unmitigated during the life of mining operations on that area. Construction of a spoil berm on the main haul road could not be made large enough to obscure the mine itself, without creating large scale spoil slopes adjacent to Good Spring Creek, which would lie in foreground visual units on slopes too steep to stabilize or revegetate.

Constructing this segment of the main haul road by cutting and hauling out the excavated material as recommended, would only partially mitigate its impacts. The path of the road would create a line-dominant feature that cannot be totally camouflaged; however revegetation of the cut banks would help to screen it. In addition it would be difficult to avoid spilling some spoil below the road, regardless of the excavating equipment.

Adverse visual impacts of the intermediate crushing and loadout facilities (though temporary), the mine office buildings, the substation, and the transmission line would be largely mitigated. However these elements could not totally borrow from the characteristic landscape, for painting with special colors is no panacea for camouflaging. Impacts of the access road would be unmitigated until successful revegetation is completed. The need for in-field technical supervision to implement some of the principles of landscape architecture might realistically prevent the complete adoption of all mitigating measures.

All dust and noise levels could not be totally mitigated. The size of the area, adverse winds, nature of overburden blasting, and coal loading procedures make total dust control unfeasible. Adverse impacts upon the area's mood-atmosphere qualities would remain unmitigated for the life of the mine.

Economic considerations might generally preclude imposition of government controls over private industry for aesthetic considerations that return unknown or questionable economic gains. Therefore proposed coal stripping operators of Colowyo mine might not be required to adopt all recommended mitigations. Internal economic considerations by W. R. Grace and Company might also preclude their desire to employ all of these mitigating measures.

The relative value of these unavoidable adverse impacts depends on the visual exposure of the landscape visual units in which they occur. The most severe adverse impacts would be those that can be viewed most directly, for the longest travel time, from the greatest number of points, and at the closest distance. Impacts would also be most severe where traffic volumes are greatest.

Travelers from other regions within the state as well as out-of-state visitors would have visual access to Federal lease D-034365 from Colorado Highway 13: these adverse aesthetic impacts would be most significant due to higher traffic volumes, and they would become more so if traffic continues to increase at 14.2 percent annually. Local residents constitute the bulk of county road users; potential visual impacts in these areas are less significant because traffic volumes are lower, and because resident attitudes are less sensitive to visual resource considerations.

The scale of W. R. Grace's proposed coal operations compared to adjacent landscapes is relatively small; therefore the degree to which unavoidable adverse impacts affect viewers would also be proportionately small.

Recreation

Destruction of unknown cultural resources could not be totally avoided by conducting reconnaissance surveys because significant resources might lie hidden below the surface. Relative magnitude of these unavoidable adverse impacts would be determined by availability of other similar recreation opportunities in the region. Impacts to unknown cultural (archeologic and historic) resources would have commensurate unknown values. As no public surface having legal public access is involved, only the private landowner would be immediately affected. The nature of the unknown cultural resource would determine whether significant public values are also present.

It would be difficult to remove all road hazards caused by increased volume of heavy truck traffic between Colowyo mine and the Craig railhead. Adverse impacts would include increased traffic hazards to recreation-oriented motorists on Colorado Highway 13.

Transportation Networks

W. R. Grace plans to start production from its Axial mine a full two years before the planned rail line is completed. This production of 620,000 tons in 1976 and 900,000 tons in 1977 would of necessity move over Colorado 13 to a tipple point south of Craig. This would necessitate upgrading the load capacity of the three bridges on Colorado 13 for such transport. There would still be unavoidable stresses on the highway due to the movement of the large volume of coal; this could result in a high degree of degradation of the road surface since the State has neither plans nor money for major improvements of this highway.

Chapter VI

Relationship Between Short-Term Uses and Long-Term Productivity of the Environment

THIS CHAPTER DISCUSSES THE EXTENT OF LONG-TERM IMPAIRMENT OR ENHANCEMENT OF RESOURCE VALUES THAT WOULD OCCUR, GIVEN THE SHORT-TERM USES OF THE ENVIRONMENT PROPOSED IN W. R. GRACE & COMPANY'S MINE AND RECLAMATION PLAN. IN THIS ANALYSIS OF TRADE-OFFS OVER TIME AND TRADE-OFFS AMONG RESOURCE VALUES, SHORT-TERM REFERS TO THAT PERIOD WHEN SUBSTANTIVE PARTS OF W. R. GRACE & COMPANY'S PROPOSED ACTION TAKE PLACE. LONG-TERM IS THAT PERIOD IN WHICH SUBSEQUENT IMPACTS, BOTH ADVERSE AND BENEFICIAL, STILL AFFECT THE ENVIRONMENT.

CHAPTER VI

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

Geologic and Geographic Setting

Paleontology

Unavoidable paleontological impacts would be experienced in the short-term during the mine's operation. After completion of the mining operation, no further impacts would occur.

Options for future use of these subsurface resources would be foreclosed by their destruction. However the operation itself could disclose knowledge of fossils heretofore unknown; this would create options for future generations to benefit from the newly-found resources.

Mineral Resources

This plan calls for a long-term period of recovery of coal from beds as deep as 450 feet, and is thus more comprehensive in coal recovery scope than any other mining plan of the region. By the end of this period, all coal that could conceivably be recovered by surface mining, would have been recovered. Use of the proposed methods, rather than underground methods, would allow a greater percentage of the coal to be recovered in a much shorter period of time.

Water Resources

Suface Water

Water courses in and adjacent to mine areas are subject to impacts throughout the operation of the mine and for several years after mining ceases, until reclaimed areas can stop eroding. Small water courses would be destroyed during the mining operations; they would be replaced during natural runoff as new channels erode. Cutting of new channels would in itself produce sediment, and carefully placed and constructed ponds must be maintained to catch and hold the sediment to prevent it from affecting more than a local area or reach of stream.

Erosion would occur because it is a natural phenomenon, but it need not be considered as an adverse action as long as it could be kept within bounds. Sediment would fill ponds and reservoirs, but this might be beneficial because vegetation would grow in the soil so formed and provide food for animals and a barrier to movement of additional sediment. Spreader systems of small dikes and dams have been constructed in other areas for this purpose to trap water and sediment in order to provide an environment for vegetation. Thus proper management of runoff from disturbed areas could be beneficial to long-term productivity even in the immediate vicinity of the mining operations.

Air Quality

Assuming that the land surface is reclaimed and returned to an equivalent of the pre-existing vegetative cover and general contours, the air pollution resulting from the mine would be a short-term phenomena; that is, it would occur only during active mining. Air pollution from vehicle exhausts and fugitive dust after mining is complete would also depend on the subsequent use of the land. Access to the properties involved would have been established. Lack of complete reclamation, specifically vegetative cover and erosion protection, could cause blowing dust to be a continual problem.

Soils

Mining on the W. R. Grace lease would result in the introduction of new roads, buildings, powerlines, and heavy equipment into an area not appreciably changed from its natural state except by electrical transmission lines, a county road, and the attendant structures associated with grazing and farming activities. The lease area would be committed to coal production for a period of about 30 years, based on anticipated production levels.

As the coal is mined, overlying soil and rocks would be removed, and vegetative production from the affected soils would be lost for a period of two-four years. The short-term use of parts of the leasehold for mining would be accompanied and followed by a period of reclamation and revegetation. At maximum production, 45 acres would be disturbed by mining each year with an equal number of acres undergoing grading and planting. At any one time the total area disturbed would be about 180 acres.

It is estimated that the total productive capacity of the land would be reduced 10 percent over present levels even if revegetation is successful. Reclamation procedures in this semiarid climate have to be tested before any final predictions can be made as to success ratios.

Terrestrial Flora

The short term uses would be the total destruction of vegetation by roads, stockpiles, facilities, the mining operation, and associated population increase. Approximately 45 acres would be totally disturbed by mining at any given time at maximum production. The establishment of vegetation would require at least three years, so the total area out of production at any given time would be approximately 180 acres, not including areas permanently removed.

Vegetation would be permanently destroyed on approximately 245 acres due to the construction of roads, permanent facilities, and population increase.

Long-term productivity is estimated to be ten percent less than existing conditions, and would depend on the success of W. R. Grace's final reclamation program.

Terrestrial Fauna

Short-term use of the Colowyo Mine lease area would entail complete destruction of that portion of the ecosystem where mining would take place, as well as all areas where roads would be built, power lines constructed, and mine buildings erected. In addition to these totally impacted areas, wildlife inhabiting adjacent lands would receive lesser impact from dust, noise, and human or vehicular activity. The lease area is relatively undisturbed at the present time so its change in use would cause a significant change in the degree of wildlife use. Short-term use of the subject area by all species of wildlife would be lessened; the degree of reduced use would depend on the ability of the species involved to adapt.

Long-term productivity would be expected to be reduced because loss in soil productivity and disruption of vegetal cover would lower the area's ability to attract and sustain wildlife. The degree and direction of wildlife replacement would depend on the reclamation program's direction and success. W. R. Grace plans to return the mined areas to a vegetation type similar to that which presently exists. This would have the effect of maintaining long-term productivity at about its present level, although it would be over 50 years before species composition and densities would be expected to approach present levels.

Short-term use of the lease area would be completely restricted to livestock use. The lease area would be fenced to exclude use by domestic fauna during mining operations. As revegetated areas become established livestock would be allowed to use the plots, thus temporarily increasing short-term use of the area.

Long-term productivity should return to, or near, present levels when revegetated areas reach maturity.

Aquatic Biology

The proposed mining activity would result in an increase in the consumptive use of the local water supply, due to increased domestic use by employees at the mine site and in surrounding towns. Local surface water drainage patterns would be disrupted for the life of the project.

Archeological Resources

Archeological values, both known and unknown, would be impacted during the short-run by actual surface disturbance. Potential for vandalism would be experienced largely in the short-term.

Options for future use of cultural resources would be foreclosed by the degree of unavoidable impact resulting from the mining operation. However required intensive cultural surveys could reveal presently hidden values; this would create options for future generations to benefit from the newly-found resources.

Historical Resources

Unavoidable impacts upon historical resources would occur only in the short-term. Once mining operations cease, the potential for vandalism and destruction of the old buildings and structures would return to its present state.

Aesthetics

The phrase "short-term" encompasses the time-frame of the proposed action, up to 2005. Given the foregoing mitigating measures short-term impacts would be significantly reduced. After 2005, long-term unavoidable impacts on the area's aesthetics would still remain, though they would be less significant than short-term impacts. However, long-term impacts would be partially mitigated with the passage of time. Examples of long-term mitigations include gradual weathering of road cuts and fills and the ecological succession that establishes plant communities on them.

Recreation

The phrase "short-term" encompasses the time-frame of the proposed action, up to 2005. Short-term use of the area would result in several beneficial impacts to recreation resources (see Chapter III) and most of this recreational productivity would remain after 2005. Increased off-road vehicle use potential and additional wildlife viewing opportunities would improve recreation capabilities on a long-term basis. Success in reclamation concurrent with ongoing mining operation would maintain increased rockhounding and geologic-industrial interpretive capabilities. However, management decisions would ultimately determine whether recreation users would have access to the mine area.

Chapter VII

Irreversible and Irretrievable Commitments of Resources

THIS CHAPTER QUANTIFIES THOSE RESOURCES THAT WOULD BE CONSUMED AND PERMANENTLY LOST AS A RESULT OF THE IMPLEMENTATION OF W. R. GRACE & COMPANY'S PROPOSED ACTION. SUCH LOSSES ARE IRRETRIEVABLE COMMITMENTS; I.E., ONCE THESE RESOURCES ARE USED, THEY CANNOT BE REPLACED.

THIS CHAPTER ALSO OUTLINES THOSE USES OF ENVIRONMENTAL COMPONENTS THAT COULD NOT BE REVERSED SHOULD THE PROPOSED ACTION BE IMPLEMENTED. ONCE INITIATED, THESE USES WOULD CONTINUE INDEFINITELY.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Geologic and Geographic Setting

Paleontology

Approval of the W. R. Grace Colowyo mine plan would be an irreversible commitment of fossil resources. Those fossils unavoidably impacted would be irretrievably lost upon completion of the mining operation.

Mineral Resources

The major irreversible and irretrievable commitment of resources by the proposed mining plan would be the production for consumption, including loss in mining, of about 93 million tons of coal in the 30-year period of 1976-2005. This was determined from the company's stated plan of producing 83,720,000 tons, and then including ten percent for loss in mining.

An undeterminable amount of sand, gravel, and clinker would be required for mine roads and other support facilities; these materials are available within a short distance of the proposed mine site.

Water Resources

Surface Water - Aquatic Biology

The total consumptive use of the local water resource resulting from the implementation of the proposed mining activity would be negligible. The decrease in aquatic habitat in the analysis area as a result of haul and access road construction would not be significant. The primary irreversible impact resulting from the proposed mining activity would involve the increase in the rate of siltation in Axial Basin Reservoir. The life expectancy of all reservoirs is based on the rate at which silt accumulates in their basins. Once a reservoir has completely silted in, its value as a resource is lost.

Air Quality

Local, very small changes in climate or the atmospheric resources would result from the redistribution of the surface material at the mine. Changes in contours and surface characteristics would irreversibly alter the wind field and surface heating of the air. The air quality degradation would be reversible if reclamation is complete.

Soils, Terrestrial Flora, and Terrestrial Fauna

Though it is difficult to predict the success of reclamation of W. R. Grace's proposed mined-over lands, returning the site to a self-sustaining ecosystem would be possible, considering existing climatic conditions and W. R. Grace's plan to replace topsoil and transplant native shrubs and trees. But productivity is projected to be ten percent less.

Wildlife resources that might be irretrievably lost include individual animals and habitats that would be destroyed. Animals and plants that would have reproduced in the affected habitats during the life of the mine might also be irretrievably lost. Most wildlife losses might be reversible if the species and habitat would not be impacted to the point that their ability to reproduce would be seriously impaired.

Annual forage production which the area could have produced would be lost during the time that mining and reclamation takes place. Production would be lost on approximately 180 acres annually; this represents an irreversible commitment of forage for livestock and wildlife. Approximately 245 acres would be permanently disturbed, and vegetative production would be irretrievably lost. Fertilizer utilized in the reclamation program would also be irretrievably lost. Existing soil associations would be irreversibly lost and soil structure would be irretrievably destroyed by the mining operation.

Archeological Resources

Unavoidable impacts to cultural resources would constitute an irreversible commitment of these resources when the mine plan would be approved. Upon completion of the mining operation, unavoidable impacts would be irretrievably committed.

Historical Resources

Irreversible and irretrievable commitments of historical resources also would occur as described above in the section on archeological resources.

Aesthetics

Commitment of Federal coal lease D-034365 to coal development would be an irreversible commitment of aesthetic resources as relates to both unavoidable and long-term minus deviations or adverse impacts. These residual impacts, for all practical purposes, would result in irretrievable resource commitments regardless of their relative significance.

Recreation

Commitment of the proposed action areas to coal development would result in irreversible commitments of recreational resources, even though they might be largely beneficial. However destruction of unknown cultural resources would be irretrievable for all practical purposes.

Chapter VIII

Alternatives to the Proposed Action

INCLUDED IN THIS CHAPTER IS A DISCUSSION OF ALL REASONABLE ALTERNATIVES TO W. R. GRACE AND COMPANY'S MINE PROPOSAL. THE IMPACTS RESULTING FROM THESE ALTERNATIVES ARE ALSO ANALYZED IN THIS CHAPTER.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

Reject Mining Plan

Rejection of the W. R. Grace mining plan would result in no environmental impact on the leased land. W. R. Grace, as surface owner of the lease, could continue to use the land for livestock grazing or other land uses. Grace could submit a new mining plan, challenge the rejection, or abandon - at least temporarily - development of the lease. Should the mining plan be rejected, the development of alternate sources of energy or a reduction of energy consumption could be required.

If energy demands are to be supplied by coal, suspending development of Federal coal at the Colowyo mine site will shift impacts to other coal regions. Utilizing coal from another area, such as the Midwest, could result in some impacts in those areas similar to those which will occur in the study area if coal development is allowed. New mines would need to be opened or production expanded at existing mines. Because much of the midwest and eastern coal is of higher sulfur content than the Colowyo coal, the resulting air pollution could be worse with utilization of that coal.

A summary of the impacts of rejecting the mine plan of Colowyo Coal Company follows:

1) Electrical generating stations in the midwest or south would have to find another source of low sulfur coal capable of meeting air emission requirements;
2) Revenue to Federal, State and local governments would not develop;

3) Traffic to Craig and Meeker would be reduced;
4) Adverse impacts on landform, geology, soils, etc. would not occur;
5) One of the few surface minable coal deposits in the region would not be utilized;
6) Loss of wildlife habitat and grazing area would not occur;
7) Use of ground water, electricity, and fuel oils would not occur;
8) Adverse aesthetic impacts, including dust and noise, would not occur;
9) Alterations in ground water flow and water quality would not occur;
10) Impacts on housing, schools, public utilities, community facilities, and community development would not occur.

Require Modification of Mining Plan

Some of the impacts identified and discussed in Chapter V could be avoided if the mining plan were modified to require use of one or more of the operational alternatives discussed below. In addition, special stipulations could be added to the plan to mitigate some secondary effects of the mining. Such conditions must be reasonable and, if economically unacceptable to the lessee, could result in the lessee not developing the coal resource.

Different Mining Methods

Underground mining

Substitution of this method of mining would result in less initial disturbance of the land surface; however, unsupported mine roofs between pillars could ultimately collapse because of the lack of structural strength in the thin overburden. The primary motivation for underground mining is that it is the most economical way to extract coal when the producing strata are located at great depths. This is not the case with several of the seams at the Colowyo mine site; the relatively shallow overburden of 50-100 feet over the X and Y seams precludes underground mining as an economic alternative for the upper seams. In addition the thin strata interval occurring between the B, C, D, E, and F seams would preclude extraction of two or more of these seams. Underground mining would not recover as much of the coal seams as surface mining, and therefore would not be a conservation measure of a valuable energy resource.

Substitution of this method of mining would result in:

1. Less initial disturbance of the land surface,
2. Subsided land surface degraded by numerous depressions and openings,
3. Greater costs because underground is more costly than surface mining,
4. A decrease in mine safety as indicated by the fatal accident rates in 1972 of 0.42/million tons mined underground versus 0.07/million tons for strip mining,
5. Higher incidence of non-fatal accidents due to roof and rib falls, fires, explosions, and problems related to dust inhalation (black lung);
6. Recoverability of reserves reduced from a potential of 90-95 percent by surface mining to less than 50 percent by

underground mining. This happens because support pillars of coal are left in place; coal is left unmined in beds less than four feet thick; coal is left in beds over ten feet thick because of less than full height mining, and other seams are left because of the thin strata interval.

Economic conditions override underground mining alternatives at the Colowyo mine site. The cost of mining coal by surface methods is approximately two-five dollars/ton, whereas underground mining generally costs six-ten dollars/ton. The difference is due primarily to labor costs, as the rate of coal production expressed in tons/man-hour is much greater for surface mining than for underground mining. Surface mining operations frequently produce more than ten times as much coal/man shift as underground mining.

The use of this technology differing from conventional surface mining methods now planned for the mine might result in a lesser impact on air quality. Underground mining would almost eliminate fugitive dust emissions.

Contour strip mining and auger mining

Contour strip mining along the various coal bed croplines, followed by auger mining, would result in a substantial reduction of land surface disturbance. However reclamation problems with the exposed highwall and with material deposited downslope are encountered with contour mining. Highwall stability problems are created by the auger mining and subsequent subsidence; the probability of uncontrolled caving and accidents is high; steep slopes and unstable highwalls are probable.

Because auger mining cannot extend further than 200-300 feet into the highwall, the coal beyond this point would be left unmined. Only about

30-40 percent recovery of coal would be realized from that portion of the coal seams mined by augering methods. Thus contour and auger mining would not be satisfactory alternatives on Grace's leasehold.

Employing this technology also differs from surface mining methods now planned for the mine and might result in a greater impact on air quality. Auger mining would probably increase the potential for air pollution by causing an increase in both fugitive dust and gaseous pollutant emissions.

In-situ production

In-situ burning of coal is at present an experimental process which involves the fracturing of coal underground and igniting it, in order to produce clean burning gas which is collected from boreholes drilled into the coal seams. Present knowledge indicates that energy recovery levels of in-situ production are low, and the amount of surface subsidence in areas of thin overburden is highly unpredictable. Impacts associated with in-situ production would include the possibility of destruction of coalbed aquifers and pollution of ground water. There would be disturbance of the surface due to the construction of facilities built to process the gas produced.

Methods for increased recovery of volatile gases must be developed for in-situ production to be a viable alternative technique. Such increases could allow in-situ production to compare favorably with the high coal recovery realized by surface mining methods.

The use of this technology, different than the conventional surface mining methods now planned at the mine, might result in a greater impact on air quality. In-situ burning also would probably increase the potential for air pollution by increasing both fugitive dust and gaseous pollutant emissions.

Different Production Ratio

Any change in production rate, either up or down, would alter the rate of intensity of the environmental impacts discussed previously in this statement. If a reduction in proposed production rate were required, it could create a shortage of fuel of this quality at the power plants in the area of consumption. This would result in decreased power production when consumption is increasing, unless substitute sources of supply were obtained. A reduction would also prolong mining activity on the leasehold, prolong the time until restoration is completed, lessen employment at the mine, lessen the acreage disturbed at any one time, lessen annual tax and royalty returns to the Federal, State, and county governments from this lease and lessen chances of the company creating an economically viable operation.

If the company were required to increase production above the level proposed, it would increase the intensity and severity of the impacts described elsewhere in the statement, decrease the length of time for mining and reclamation, increase annual tax and royalty returns from this lease, and necessitate acquisition of additional mining equipment.

The establishment of a non-uniform production rate, varying seasonally or even daily, matched to climatic conditions favorable to dust suppression, could result in a significant reduction in expected ambient suspended particulate concentrations.

Different Reclamation Objectives

Alternate land uses for the disturbed areas are discussed in Chapter X of the Regional Analysis. Grazing land for domestic livestock, wildlife habitat and recreation, or combinations of these would be the objectives that would be permitted by the topography at the Colowyo mine site.

Different Transportation Methods

Truck transport

W. R. Grace has already decided on a rail line from their Axial mine site for transport of their coal to the Craig branch of the D&RGW and has done much of the preliminary planning work. Colorado 13 will probably not stand up to even two years of heavy coal hauling at under one million tons/year. With a production of three million tons/year for the three benchmark dates of 1980, 1985, and 1900 for the mine at Axial, use of this road for more than two years for coal transport is out of the question.

Slurry pipeline

A coal slurry pipeline is another alternative to use of rail or truck transport of coal. A line as described in the Regional Analysis could easily handle the three million ton/year production of the W. R. Grace mine. If the slurry pipeline were used only for transport to the railhead (the distance of the proposed coal-haul rail line), no pumping stations would be needed along the right-of-way, and except for preparation stations at each end the impacts of a buried pipeline would be small. If the pipeline were to move the coal over a long distance to market bypassing D&RGW, the impacts would be considerably greater.

Consumptive use of water is the basic problem with a coal slurry pipeline. Since it takes about one ton of water to move one ton of coal, large amounts of water would have to be supplied to W. R. Grace (probably from the Axial basin area), and subsequently disposed of at the terminus of the pipeline.

Another disadvantage of this transportation method is the high potential for freeze-up in northwestern Colorado during the long, cold winters. Operational failures are difficult to detect and correct in this area, especially during the winter. During all seasons, the probability of a pipeline break or leakage always exists. As the line would cross underneath many small streams, there is a high potential for damaging spillage with resulting water and land pollution. Any spillage or leakage into water courses would result in damage to aquatic life, aesthetics, and recreation values.

If the use of a valuable natural resource such as water is not prohibitive in this case, a slurry pipeline might be a realistic alternative for hauling coal produced at the W. R. Grace mine.

Alternative transport of coal, other than by haulage truck, would decrease vehicle exhaust emissions and road fugitive dust.

Conveyor belts

Belt conveyors can be used as an alternative to rail or truck transport of coal. Expertise is sufficiently advanced to assure technically sound construction of single or multiple flight belt conveyors. Belt conveyors offer great design flexibility and economy in instances like this, where distance and quantity requirements are well known and are expected to remain relatively fixed (at three million tons/year).

In general, conveyor system construction would cause impacts similar to railroad construction. Long distance belt conveyors have never been constructed. However, a 20-30 mile belt could probably be constructed requiring extensive design work.

A belt conveyor would be subject to belt lift by wind, and would create quantities of coal dust downwind; to decrease dusting, the entire length of the system would be necessarily hooded or guarded against wind. This would add to the visibility of the structure and increase the impact on wildlife and the aesthetics of the area. Electric motors are normally used to power the belts. They would be located at frequent intervals along the lines, requiring service roads, electric transmission lines, and other service facilities.

If W. R. Grace were to use a conveyor belt system instead of a rail line, it would probably be only to the D&RGW branch line and not over long distances to distant markets. Fairly extensive land areas would be required at the end point where the coal was to be transferred to unit trains. At this point, large surge capacity would be necessary because the belt system would be transporting three million tons of coal/year at a relatively constant rate for subsequent movement. Unit trains would provide this capacity.

Since the impacts of a conveyor belt system are similar to rail, and since the environmental and design problems of a rail line have been considered by W. R. Grace already, one would hesitate to recommend a conveyor belt over the rail line for coal hauling in this case. Use of unit trains from the mine site also eliminates the transfer point from conveyor belt to train at the rail head.

The decrease in vehicle exhaust emissions and road fugitive dust also applies to this alternative insofar as truck haulage would not be used.

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